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The Sialographic Differentiation of Mikulicz's Disease and Mikulicz's Syndrome[1]

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"I hope that future observers will succeed in solving the riddle which this remarkable disease presents to us."
Mikulicz, 1888

IN THE SEVEN decades since Mikulicz described the disease entity which bears his name, there has been much confusion between Mikulicz's disease and Mikulicz's syndrome. The literature records attempts to differentiate the two by means of biopsy, but histopathology, particularly in Mikulicz's disease, is uncertain. Most of these reports (3, 15, 17, 20) were written before the advent of sialography, and more recently this diagnostic approach has been employed only sporadically, and then with conflicting observations (2, 30, 46, 47). It was for this reason that sialographic studies were undertaken in a group of patients with salivary gland swellings in which histologic proof of Mikulicz's disease or Mikulicz's syndrome had been obtained. The resulting roentgenograms have shown a pattern of variations indicating that sialography can be used for the differential diagnosis of the two conditions.

Historically, the disease was first identified in 1888 by Johann von Mikulicz-Radecki (23), who described it as a distinct clinical and pathological entity having as its chief characteristic symmetrical tumefactions of the lacrimal and salivary glands which develop gradually, are hard in consistency, painless, and unassociated with other organic involvement. Microscopic examinations of the excised portions of the gland disclosed atrophy of the acinar parenchyma and diffuse replacement by lymphoid tissues.

In the following years numerous reports attempted to classify the variations found in what appeared to be cases of Mikulicz's disease. Von Brunn (3) in 1906, and Howard (15) in 1909, distinguished between the disease and pseudoleukemia and true lymphatic leukemia, but this simple classification failed to take into account the varied causes of lacrimal and salivary gland swellings. A more elaborate classification on etiological grounds was made by Thursfield (53) in 1914, and finally Schaffer and Jacobsen (45), in 1927, distinguished between Mikulicz's disease and Mikulicz's syndrome. This remains the accepted classification today and contrasts Mikulicz's disease with its uncertain histopathology against Mikulicz's syndrome, of more clearly defined pathologic nature, including such entities as leukemia, the lymphomas, sarcoidosis, tuberculosis, and syphilis.

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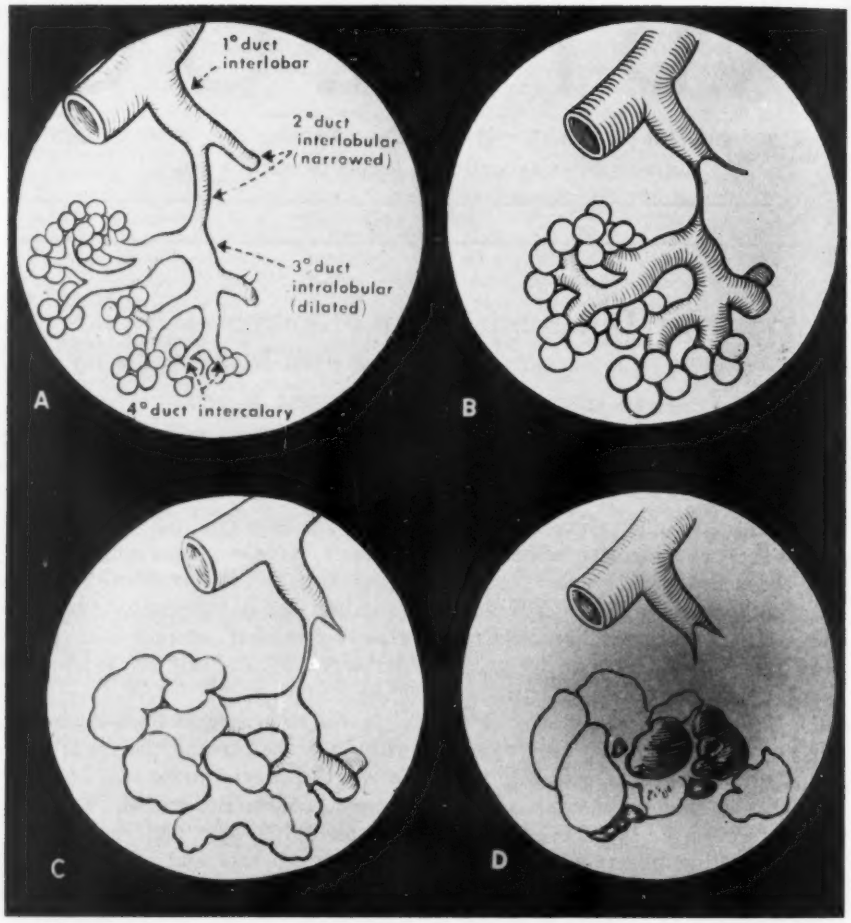


Fig. 1. Staging of sialectasis based on sialographic-histopathologic studies.

A. Punctate stage. The earliest findings in sialectasis are a punctate dilatation of the peripheral ducts, which may be under 1.0 mm. in diameter. With recurrent episodes of parotitis, the *interlobular* ducts are narrowed by periductal lymphocytic infiltration and septal fibrosis. Functioning acinar tissue continues to secrete against a narrowed duct system, resulting in retention of saliva in the *intralobular* ducts, which then dilate.

B. Globular stage. In moderately advanced disease the globules of contrast material increase to 1 to 2 mm. in diameter but remain uniform in size and distribution. It is at this stage that the sialographic findings of terminal duct dilatation and lack of intraglandular branching correlate with the scarcity of *interlobular* ducts located in the septa of the gland and the wide lumens of *intralobular* ducts in the histologic sections.

C. Cavitary stage. In advanced stages there is a coalescence of globules, which become irregular in size and distribution and decrease in number. The *intralobular* ducts continue to dilate and form cysts, resulting in the cavitary appearance observed on the sialogram.

D. Destructive stage. In the end stage of sialectasis there is a bizarre pattern suggesting neoplastic invasion and destruction of the gland. Histologic sections support the roentgen findings in that there is no recognizable duct structure, because of lymphoid infiltration and fibrosis of diffuse areas of gland parenchyma. Differentiation from neoplastic disease can be made by demonstration of multiglandular involvement in this stage of sialectasis.

The sialographic studies comprising this series were initiated at the University of Michigan and continued at the National Institutes of Health, Bethesda, Md. Forty-three patients have been examined. More than one hundred sialograms have been completed in which reflex stimulation of the salivary glands has been employed.

There were 29 cases of Mikulicz's disease (see Table I) and 14 of Mikulicz's syndrome, the latter group including 3 cases of leukemia, 5 of lymphoma, 5 of sarcoidosis, and 1 of tuberculosis.

MIKULICZ'S DISEASE

There is no consistent clinical pattern of symptoms in so-called Mikulicz's disease. A large number of cases substantiated by histologic sections dispel the classic concept of painless, symmetrical enlargement of lacrimal and salivary glands as essential features. In some patients the disease presents in a unilateral fashion (26); in some either the salivary or the lacrimal glands alone are involved (36, 49); in some the onset is acute and the swelling tender rather than chronic and painless (41). Considerable age variation (five to eighty-two years) has been noted. Sex is not a vital differentiating factor.

In this era of specialization, the mode of presentation often determines to which medical division the patient will be referred. Accordingly, the surgeon will see most of the patients who manifest unilateral swelling of the salivary glands; the ophthalmologist those with keratoconjunctivitis sicca or enlargement of the lacrimal glands; the rhinolaryngologist those complaining of dryness of the nose, mouth or throat; the pediatrician those children with recurrent sialadenitis mistaken for mumps; the internist those with associated rheumatoid arthritis and other collagen diseases. The radiologist is in a pivotal position in that roentgen examination is a common step in the diagnostic work-up. It is appropriate, therefore, to consider the various reasons for which sialography may be requested, depending on the clinical symptoms (see Table I).

The main roentgenographic feature in Mikulicz's disease is sialectasis which, on the basis of film findings, can be divided into four stages: punctate, globular, cavitary, and destructive (Fig. 1). The earliest finding is a diffuse, punctate dilatation of the peripheral ducts, which may be less than 1 mm. in diameter (Fig. 2).

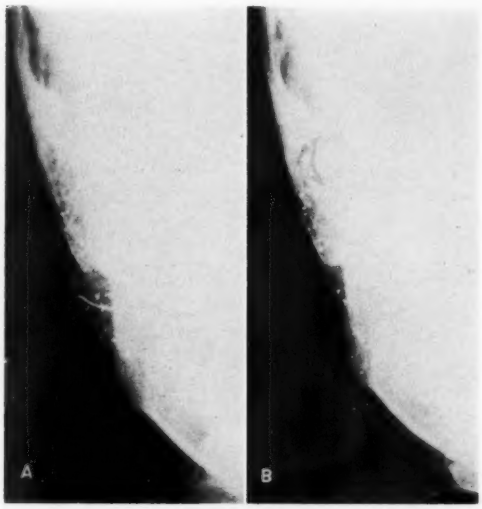


Fig. 2. Recurrent sialadenitis in a child.

A. Film showing punctate dilatation of the terminal ducts (anteroposterior view).
B. Following stimulation, the residual contrast material in these ducts is again seen.

The main duct is of normal caliber but careful examination shows that the lumens of the second to fourth order ducts are narrowed to fine linear channels. Tissue sections at this stage show a periductal, lymphocytic infiltration about the septal ducts (interlobar and interlobular). With repeated exacerbations, fibrosis and scarring result in the interstitial areas and these septal ducts become narrowed.

In moderately advanced disease, the globules of contrast medium increase to 1-2 mm. in diameter but remain uniform in size and distribution (Fig. 3). The main duct is still of normal caliber, but the intraglandular duct divisions are obliterated further. Functioning acinar tissue continues to secrete against this narrowed duct system, with the result that saliva is retained in the intralobular ducts, which then dilate. It is at this stage that the sialographic findings of terminal duct dilatation and lack of intraglandular branching are in accord with the microscopic picture of a sparsity of interlobular and interlobar ducts and a widening of the lumens of the remaining ducts.

In the advanced or cavitary stage, the

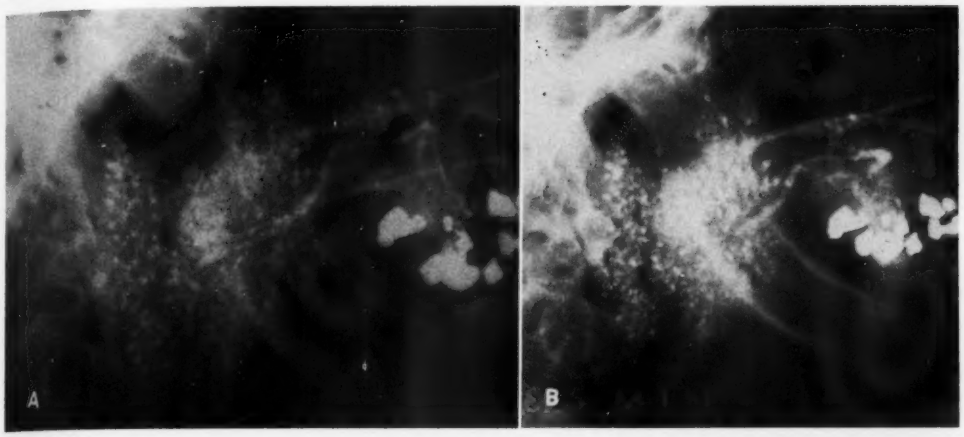
TABLE I: VARIOUS DIAGNOSES IN SO-CALLED MIKULICZ'S DISEASE

Medical Specialty and Diagnosis	Cases in Present Series	Presenting Symptoms	Sialographic Findings	Pathology
Ophthalmology Sicca syndrome	12	Keratoconjunctivitis sicca; dryness of nose, mouth and throat; enlargement or atrophy of parotid; rheumatoid arthritis (48–51)	Sialectasis has been uniformly reported and the changes noted roentgenographically correlated with clinical staging (32, 41)	Careful review of microscopic sections available suggest Mikulicz's disease is similar to Sjögren's syndrome (24, 26)
Otology Recurrent pyogenic parotitis	6	Recurrent painful swellings of parotid gland lasting from days to weeks (35)	This is the group most thoroughly explored by sialography; it always shows sialectasis on films (35–37)	Pathological sections of cases of chronic sialectatic parotitis following parotidectomy indicate many cases of chronic parotitis have been labeled Mikulicz's disease in the past (34)
Surgery Benign lymphoepithelioma	2	Firm, unilateral, non-tender parotid swellings suggesting tumefactions (35)	Terminal duct dilatation characteristic of sialectasis found in sialograms reported (11, 52)	Some of the manifestations of this pathologic process suggest a fundamentally inflammatory nature, whereas others seem neoplastic. Parallels to Mikulicz's disease noted (41)
Pediatrics Recurrent sialadenitis	6	Recurrent, painful parotid swellings, or recurrent mumps related to infection, allergy and avitaminosis (21)	Sialectatic pattern in all cases studied (38)	Studies in infants and children reveal interstitial fibrosis and replacement of lobules by lymphocytes (54, 55)
Internal Medicine Mikulicz's disease	3	Chronic rheumatic polyarthritis; scleroderma; disseminated lupus erythematosus and other collagen diseases (27, 49)	Earlier sialographic studies were reported as normal (2, 46). Present series indicates sialectasis is present.	Suggests possible relationship between collagen diseases and salivary and lacrimal gland enlargement (26)
Dentistry Severe xerostomia	1	Unnatural history of dental caries and crumbling or falling out of teeth despite good oral hygiene, when associated with xerostomia (6)	No abnormalities reported previously (2). Sialectasis found in present study.	Relationship of dental caries to absence of saliva observed in salivary gland extirpation in rats (4) and post-irradiation in man (39)

films show an apparent, although not an actual, coalescence of globules, which are irregular in size and distribution and increased in number. There are also filling defects due to cystic dilatation. Pathologically, lymphoid replacement and increasing fibrosis result in a loss of acini. In some areas the acini are involved to a lesser extent and secretion continues to produce further dilatation and cysts, resulting in the cavitary stage. The myoepithelial cells line and obliterate the lumens of the intralobular ducts, which accounts for the fewer globules of contrast medium visualized roentgenographically.

In the end or destructive stage, no recognizable branching duct system is found sialographically. The radiopaque material dissects its way into the septa of the gland and the subcapsular space. Microscopically, this may be explained by the fragmentation and gradual disappearance of the reticular and collagenous tissue supporting the duct wall (34). The total absence of the duct architecture is due to lymphocytic replacement and scattered myoepithelial islands, which also account for the bizarre destructive pattern seen on the films. At this stage, the radiopaque material can be injected with extreme ease, so much so that over-injection of the gland readily occurs.

The degree of emptying following stimulation is an index of salivary glandular function. The retention of the contrast material in the terminal ducts is due to the



inability of the secretory pressure of the acini to overcome the resistance offered by the narrowed interstitial or septal ducts. The larger the retained globule, the greater the obstruction and the slower the emptying of contrast material. Serial films taken at intervals of five minutes, one-half hour, one hour, and twenty-four hours permit evaluation of the degree of secretory function in cases where scant flow exists (Fig. 3). The failure of Stenson's duct to empty, as shown in the five-minute stimulation film, is in keeping with the degree of xerostomia seen clinically. The bizarre pattern of the end stage remains without change for days to weeks, since no acinar tissue remains and the contrast material has permeated the gland septa.

In dividing the cases into stages on the basis of sialograms, it should be recognized that oversimplified criteria have been established in portraying this disease. In some patients the degree of involvement may be in the punctate stage in one parotid gland and in the cavitary stage in the other. Although it seems reasonable to assume that with repeated exacerbations the sialographic changes will be progressive, we have not followed early cases long enough to substantiate this hypothesis. Occasionally, a fusiform dilatation of the duct system occurs with changes similar to those seen in obstructive sialodochiectasis due to strictures and calculi.

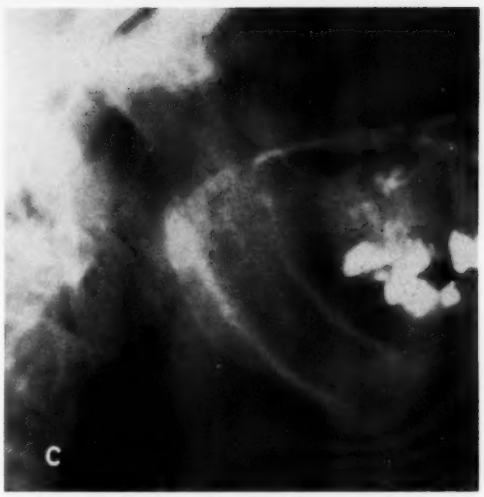


Fig. 3. Sjögren's syndrome.

A. The typical "mulberry" pattern of the globular stage of sialectasis is seen. Note the involved accessory lobe. This is typical of sialectasis in which the entire gland is involved.

B. Five minutes after stimulation, the contrast medium has not been evacuated; this correlates with the decreased salivary flow clinically.

C. One hour later most of contrast medium has been evacuated, indicating some residual function.

The reason for this is inspissation of saliva in the main duct producing obstruction to the salivary flow. No main duct calculi have been reported in association with sialectasis.

The explanation of why this apparently diversified group of cases of Mikulicz's disease yields a similar and characteristic roentgenographic pattern of sialectasis

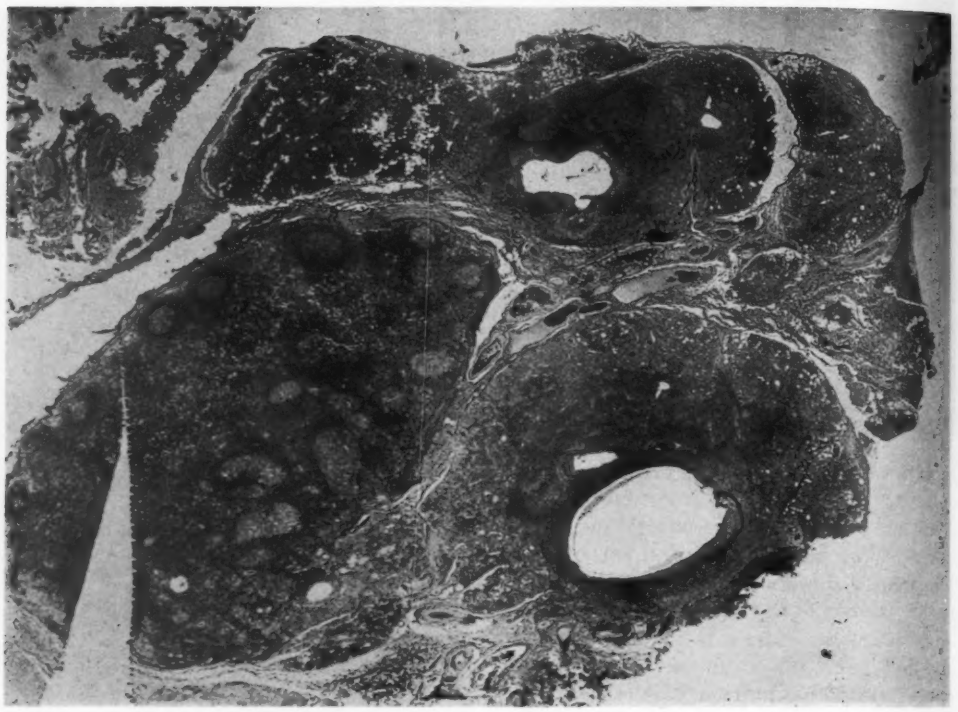


Fig. 4. Histologic section showing dilatation of *intralobular* ducts and sparcity of *interlobular* septal ducts. This parallels the sialographic findings of dilated terminal ducts and lack of intraglandular duct branching. ×14

must lie in the pathologic process. The common pathologic finding in cases of sialectasis is an inflammatory response initially arising in the interstitial septa of the gland with eventual replacement of the parenchyma (Fig. 4). The degree of change depends on the etiologic agent and the duration of the disease, and it is on this basis that sialographic findings can be staged and integrated with the biopsy specimens obtained (44).

MIKULICZ'S SYNDROME

Under the heading "Mikulicz's syndrome" we include all those apparent symmetrical enlargements of the lacrimal and salivary glands which are manifestations of a pathologically defined disease. Entities commonly considered in this group are leukemia (10, 17), lymphoma (9), Hodgkin's disease, Boeck's sarcoid (22), tuberculosis (1, 15, 16), and syphilis (31). These diseases are essentially systemic in origin, with lymph node involvement as the outstanding clinical feature.

Leukemia, whether acute or chronic, involves consistently all lymph node bearing areas (Fig. 5A). Lymphomas and particularly Hodgkin's disease frequently present in the cervical-facial areas, producing a "Mikulicz facies" simulating parotid and submaxillary gland involvement (Fig. 6A). Tuberculous cervical lymphadenitis is of much greater frequency than tuberculous parotitis and accounts for the confusion with salivary gland swellings in clinical examination. Enlargement of pre- and postauricular, submaxillary, and submental lymph nodes is a conspicuous trait of sarcoidosis.

The sparsity of pathologic evidence in the literature indicates the rarity of salivary gland involvement in these diseases. The initial theories (3, 15) of the progression of Mikulicz's disease through pseudoleukemia to true lymphatic leukemia and

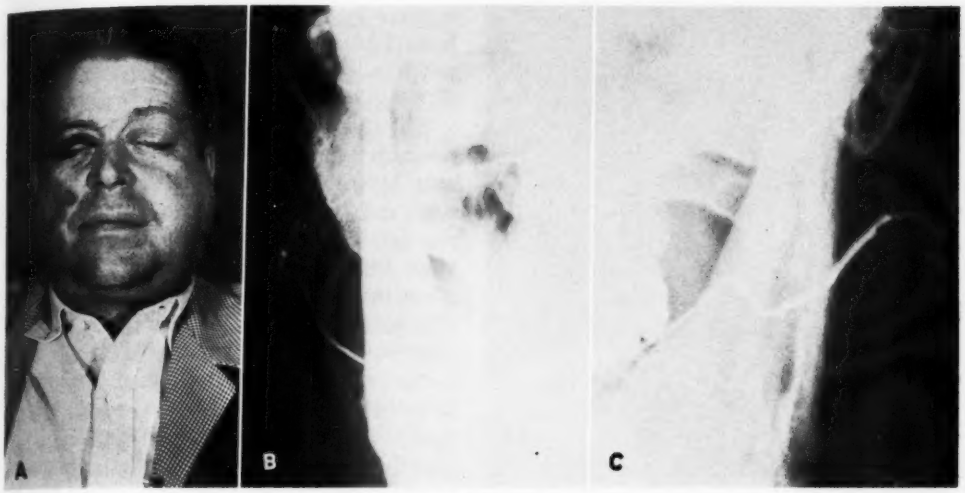


Fig. 5. Leukemia

A. Classic Mikulicz facies due to swellings in region of salivary glands secondary to leukemia.
B. The right parotid gland architecture remains intact in this moderately advanced phase of Mikulicz's syndrome.
C. The left parotid gland is displaced laterally also and there is a decrease of arborization. The emptying phase (not shown) revealed complete evacuation of contrast medium of both parotid glands.

lymphoma have been discarded on the basis of later observations. In the classic descriptions of uveoparotid fever (22), there is a striking absence of reproductions of histologic sections showing the tubercles of sarcoid in salivary parenchyma (12). In a convincing surgical study of tuberculous disease of the parotid gland, Patey and Thackray (33) concluded that in the early stages the tuberculous process is confined to adjacent lymph nodes and later may extend into adjoining parotid tissue. Syphilitic parotitis has been an extinct entity for the past three decades. Unfortunately, most of the pathologic material has been obtained at autopsy in the end-stages of the condition, since surgical exploration to identify the origin of swelling in the salivary gland region in the known presence of systemic disease is solely of academic interest.

Sialography is well designed for differentiating between swellings due to lymph node enlargement and those due to salivary gland enlargement. Roentgen studies (46, 47) show that the salivary gland architecture remains intact in the early to moderately advanced phases of Mikulicz's syndrome. In these stages, when the process is limited to the adjacent lymph nodes, a normal branching duct system is seen with lateral displacement (Fig. 6B). The emptying phase reveals complete evacuation of the contrast medium, as is seen characteristically in extracapsular neoplasms. It is difficult to estimate from the size of the clinical swelling or from the amount of parotid displacement, as demonstrated on films, the degree to which salivary flow has been impaired unless the gland is stimulated reflexly.

In the late stages of Mikulicz's syndrome, the primary pathologic process invades the substance of the parotid gland and there is a striking decrease in the arborization (Fig. 5B). Small amounts of contrast material (less than 0.5 c.c.) often produce pain, indicating that the capacity of the duct system has been reached. Finally, as the disease advances, the entire gland is infiltrated and replaced. Occasionally small scattered areas of retention occur, but this is the exception rather than the general rule. The ability of the gland to function is maintained despite infiltration of the parenchyma.

lobular architecture. Sialectasis has not been found in our studies of these cases, nor has it been reported by other authors (30, 35, 36, 41).

The reason for the similar clinical picture presented by cases of Mikulicz's disease and Mikulicz's syndrome is based on the anatomic and embryologic development of the salivary glands. It should be stressed that the lymph nodes and the parotid gland anlage are intimate in location, as documented by Nicholson's (29) and Rouvière's (42) studies on the fetus and newborn. Careful examination of the normal parotid reveals a series of small lymph nodes embedded in the substance of the gland, the largest being 5 mm. in diameter; occasionally small branching ducts can be seen entering the hilus of a node. These parotid lymph nodes are 8 to 14 in number and are most often situated medially and toward the periphery of the gland (27).

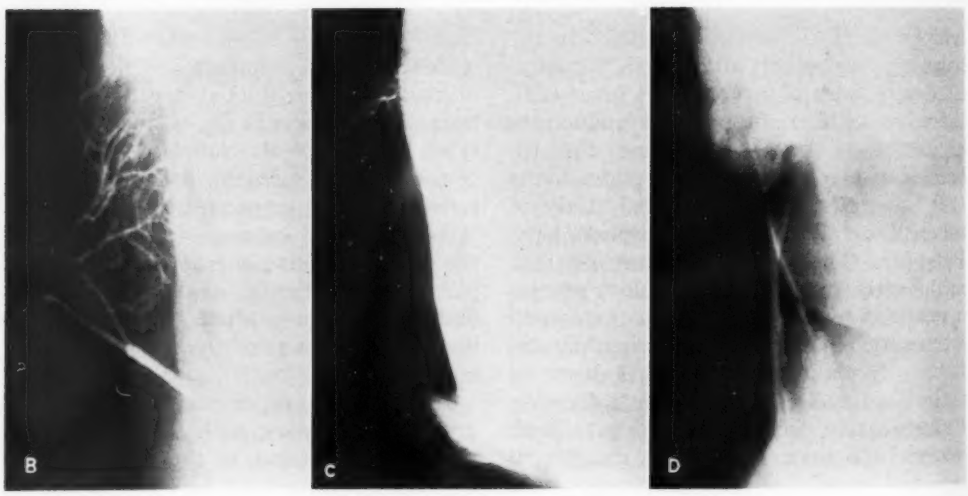


Fig. 6. Malignant lymphoma

A. Swellings in the lacrimal and salivary areas, present for six years.
B. The left parotid gland is displaced laterally but the duct system remains intact.
C. Basilar view accentuates the lateral displacement. Note destruction of the zygomatic arch secondary to tumor invasion.
D. Following stimulation, small scattered areas of retention are noted, suggesting some invasion of the salivary gland substance. This was established on biopsy.

In the terminal stage it is impossible to inject radiopaque medium, as Stenson's duct becomes obstructed from fibrosis and from invasion by the disease process. Microscopically there is complete loss of

DISCUSSION

Although the true nature of Mikulicz's disease is unknown, it is probably inflammatory and its histologic pattern remains consistent in spite of the varied anatomic

setting and evolution of the lesion. Clinically, the localized nature of the process, without lymph node involvement, is a basic finding. The gland is affected diffusely but retains its normal lobular structure, although the individual lobules may be greatly enlarged. Sialographic studies in Mikulicz's disease, in contrast to the syndrome, show enlargement of the salivary gland without evidence of displacement. The branching duct system is characterized in the early to moderately advanced stages by terminal duct dilatations or sialectasis. These are referred to in the gross specimen as cystic areas and microscopically are identified as intralobular ducts. In advanced cases, as seen roentgenographically, the main duct is normal in caliber and the contrast substance no longer outlines ducts but enters the interlobular septa and eventually the subcapsular space.

It is apparent that the diseases commonly listed under the heading of Mikulicz's syndrome are systemic diseases with lymph node involvement. On the basis of our present sialographic studies, the salivary gland architecture has been demonstrated to be intact in the early to moderately advanced phases. The persistent displacement of the gland in only the lateral direction is compatible with the medial location of the parotid lymph nodes. The complete evacuation of contrast medium, which also occurs in extracapsular neoplasms, is additional proof of the origin of the disease process in lymph nodes intimately related but external to the salivary parenchyma. In the terminal stages of Mikulicz's syndrome, salivary gland involvement occurs secondarily and results in complete destruction of the obular architecture, rendering sialograplhic studies impossible, due to obstruction and fibrosis of the main duct.

The importance of the present study clinically is in those patients who are seen with bilateral (or unilateral) swellings about the parotid-submaxillary gland area, with or without associated lacrimal gland enlargement. A differential pattern has been noted on sialograms in histologically proved cases of Mikulicz's syndrome and of the inflammatory process known as Mikulicz's disease. Mikulicz's disease is self-limiting and has no mortality. Its early recognition will lead to the institution of more conservative therapy and obviate the risk of surgery and the hazard of facial nerve damage (34, 52). It has been treated successfully by x-ray therapy (13, 20), radium (15), antibiotics (41), and steroids (51). Biopsy is recommended to establish a definite histologic diagnosis. Correlating biopsy findings with other laboratory and diagnostic tests, including sialography, will help to give additional insight into this relatively unexplored group of diseases.

SUMMARY

1. Mikulicz's disease and Mikulicz's syndrome can be differentiated on the basis of sialographic studies.

2. In Mikulicz's disease, which originates in the salivary gland, sialectasis or terminal duct dilatation characterizes the early to moderately advanced stages.

3. In Mikulicz's syndrome, which secondarily involves the salivary gland, sialograms in the early to moderately advanced phases show the gland architecture to be intact but displaced laterally.

4. In the end stages of both Mikulicz's disease and Mikulicz's syndrome, the gland architecture is completely replaced or destroyed. In Mikulicz's disease, the radiopaque medium can be readily injected, making its way into the septa of the gland, in contrast to Mikulicz's syndrome, in which the main duct is obstructed and injection is impossible.

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SUMMARIO IN INTERLINGUA

Differentiation Sialographic Inter Morbo de Mikulicz e Syndrome de Mikulicz

Le distinction inter morbo de Mikulicz e syndrome de Mikulicz, secundari a morbos systemic como leucemia, lymphoma, sarcoidosis, e tuberculose, pote esser facite per medios sialographic. In morbo de Mikulicz, que ha su origine in le glandula salivari, sialectasis o dilatation de ducto terminal es un characteristica de stadios precoce e moderatemente avantiate. In syndrome de Mikulicz, que affice le glandula salivari secundarimente, sialogrammas obtenite in le stadios precoce e moderatemente avantiate monstra un architectura glandular intacte sed lateralmente displaciate. In le stadios terminal de morbo de Mikulicz si ben como de syndrome de Mikulicz, le architectura glandular es completemente reimplaciate o destruite. In morbo de Mikulicz le medio radio-opac es facile a injicer, e illo progrede facilemente a in le septos glandular. In syndrome de Mikulicz le ducto principal es obstruite e nulle injection es possible.

Es reportate un serie de 43 casos, incluse 29 de morbo de Mikulicz e 14 de syndrome de Mikulicz.

Colloidal Stannic Oxide

Animal Studies on a New Hepatolienographic Agent[1]

HARRY W. FISCHER, M.D.

CLINICIANS HAVE long desired safe and dependable radiographic visualization of the liver and spleen. One approach to this problem is based on the ability of the reticulo-endothelial cells of these organs to phagocytize colloidal particles from the blood flowing through their finer vascular channels. Selection of a colloidal substance of a relatively high atomic number is essential to provide contrast with adjacent tissue. If, then, the liver and spleen are perfused over a limited period with a large number of minute particles of high atomic number, the constituent cells will engulf the particles, each such cell becoming more radiopaque than cells not containing these particles. As a result, the entire organ may be demonstrated by standard radiographic technics. Also essential to success is a particle of proper size, one which will not occlude a capillary. When the contrast agent is susceptible to metabolic change or excretion, a time limit for its introduction and for performing the radiographic study enters the problem.

To be safe and trustworthy, the method must be without immediate or eventual harm to local tissue or the whole organism. A low incidence of minor reactions may be tolerated, but serious acute reactions to a procedure prohibit its use. Ample evidence must also exist to insure against any subacute or chronic disability stemming from the use or retention of the medium.

In previous attempts at hepatolienography based on the phagocytic function of liver and spleen cells, heavy metal compounds, the oxides of thorium and tantalum (1–3), and iodinated fatty substances (4–7) have been employed. Their injection, however, has produced either acute reactions or delayed injury to cells and organs.

Ethyl triiodostearate and ethyl-diiodostearate have not been widely accepted because of frequent minor and severe reactions attending their intravenous injection (5, 8). Thorium dioxide has been condemned because of its radioactivity and its permanent retention in the body (9). Some evidence has indicated that it is productive of tissue fibrosis and stimulates neoplasia.

Colloidal stannic oxide, a new hepatolienographic agent, shows considerable promise of being safe and dependable (10). Preliminary animal studies indicate that it can be given intravenously without acute or delayed reaction. Tin, of atomic number 50, is of sufficient radiopacity that excessive amounts are not necessary to obtain dependable radiographs. Being insoluble, and in colloidal form, the oxide is selectively deposited in the reticulo-endothelial cells, with only a negligible portion remaining in other body tissues. It is not radioactive. While it is indefinitely retained in the body, ample evidence exists to show that it is innocuous. Elimination of stannic oxide from the body is apparently not possible on the basis of present evidence.

EXPERIMENTAL WORK

The early experimental work on colloidal stannic oxide as a contrast medium for liver and spleen has had several interrelated parts, but for purposes of discussion the following can be considered in order:

I. Radiopacity of tin and stannic oxide
   A. Physical studies
   B. Animal radiography
II. Selection of a suitable colloidal suspension
III. Toxicity of tin and of stannic oxide
   A. Immediate
   B. Ultimate

[1] From the University Hospitals, State University of Iowa, Iowa City, Iowa. Accepted for publication in October 1956.

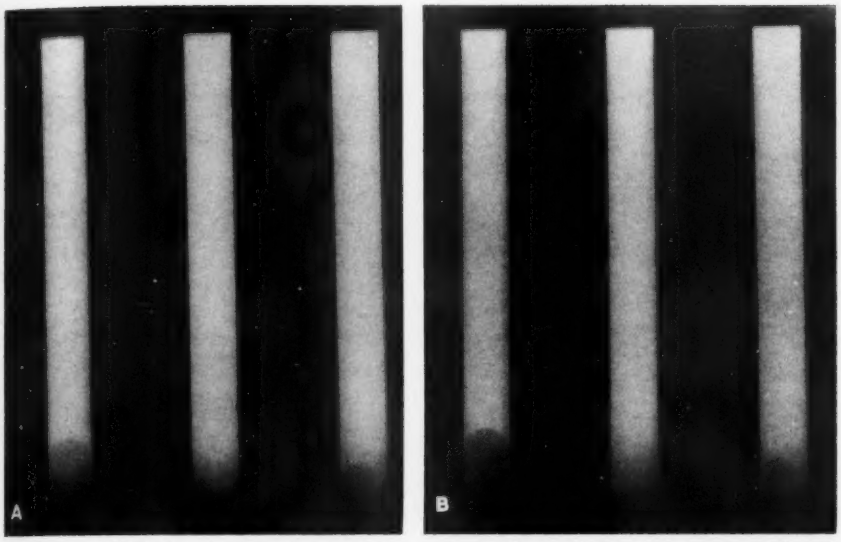

Fig. 1. A. Lucite phantom study of 10 per cent solutions of iodine (left), tin (center), and thorium (right). Lucite phantom was 19 cm. in thickness, and film was made at 60 kvp, 300 mas, 36 inches distance, with Bucky diaphragm. The three solutions are of essentially the same radiopacity.

B. Similar study at 80 kvp, 150 mas, showing equal radiopacity despite the higher kilovoltage.

I. *Radiopacity:* The radiopacity of tin was investigated with a Lucite phantom of 19 cm. thickness. Since iodine and thorium have given satisfactory opacity in clinical usage, they were used as standards for comparison. Ten per cent weight/volume solutions of tin, iodine, and thorium were placed in identical tubes and inserted in the center of the phantom. Radiographs were taken at 40, 60, and 80 kvp with standard x-ray apparatus. In this range of clinical radiography, tin, favored by its absorption curve, was found to have excellent radiopacity; it is certainly equal to iodine and thorium (Fig. 1, A and B).

The radiopacity of tin oxide as a contrast material for liver and spleen was investigated by comparison with thorium dioxide in adult rabbits. Thorotrast, a colloidal solution of 24 to 26 per cent of thorium dioxide by volume, was given to rabbits in a dosage of 1 c.c. per kilogram of body weight, the maximum safe dosage recommended for human use. Other animals received colloidal stannic oxide, either a single dose of about 350 mg. of tin per kilogram of body weight or two such doses with an interval between. One rabbit was given three of the single doses, and another received four. The rabbits ranged in weight from 2.6 to 4.7 kg., a majority weighing 3.4 to 4.3 kg. All animals were of the same stock and coloration, and were obtained from the same kennel. All were treated identically as to diet, caging, handling, and technic of injection.

Pre- and post-injection films were made with identical factors for the respective kilovoltages. At 40 kv, all rabbits were filmed at 200 ma and 1/4 second; at 60 kv, at 200 ma and 1/20 second; at 80 kv, at 100 ma and 1/20 second. All films were made at a 30-inch tube-to-film distance, with Bucky grid, a large cone, and 3.0 mm. of aluminum filter added. Under these conditions, it was thought that variable factors had been minimized and that the resulting radiopacities were dependent on the contrast agents tested and on internal physiological conditions, which were either unknown or not immediately controllable.

Although opacification of dog liver and spleen was also obtained by injections of colloidal tin oxide, it was felt that with the limited number of dogs used an accurate comparison with other contrast materials

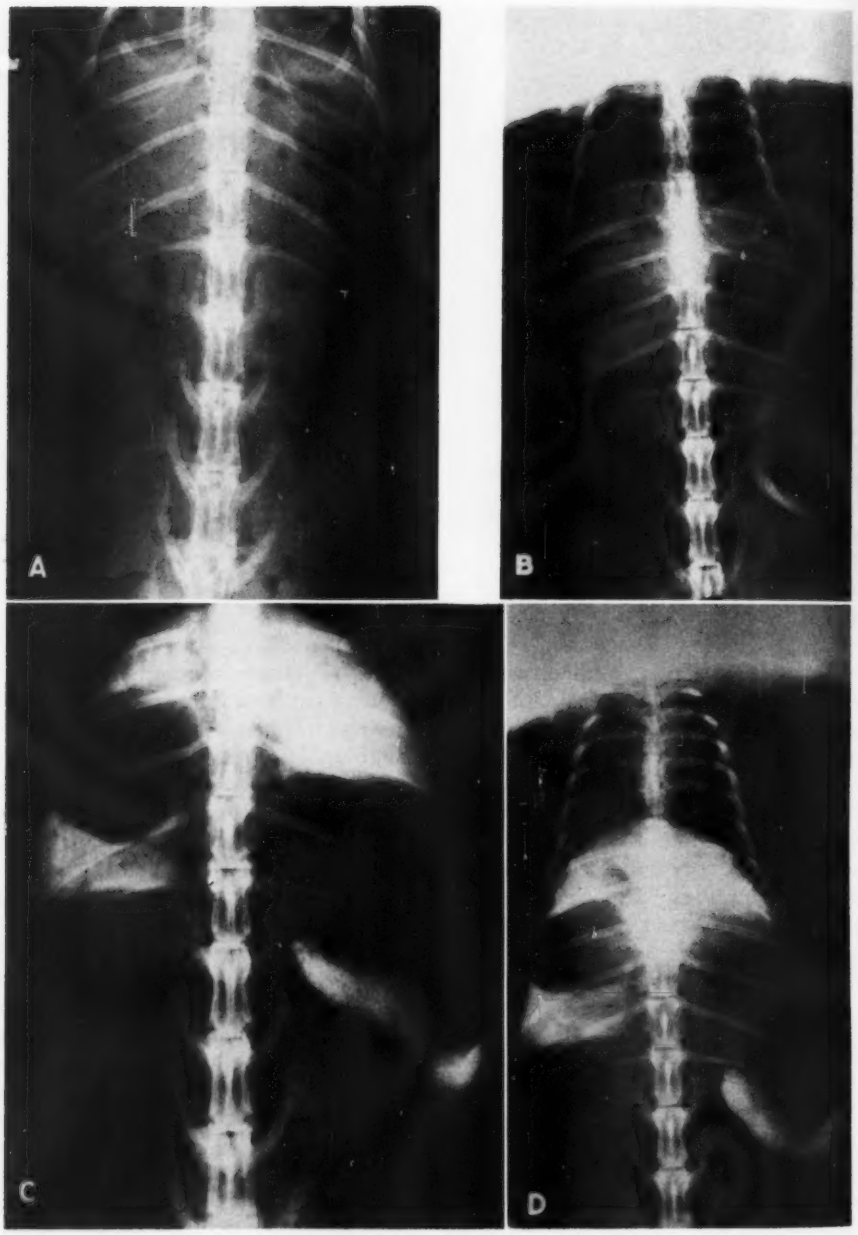

Fig. 2. A. Rabbit abdomen before injection of contrast material.
B. After an intravenous injection of colloidal stannic oxide, 374 mg. of tin per kilogram of body weight.
C. After an additional injection of 374 mg. of tin per kilogram of body weight.
D. Same animal one month after the second injection.
The liver and splee aren opacified after the first injection. After the second injection the shadow is more striking. The late film shows long retention of the contrast material, both an advantage and disadvantage. Compare B and C, especially the latter, with Fig. 3B.
These films and all other films of rabbit abdomens were made with the following factors: 60 kvp, 200 ma., 1/20 second, 30-inch tube-to-film distance, Bucky grid, large cone, 3.0 mm. Al filter added.

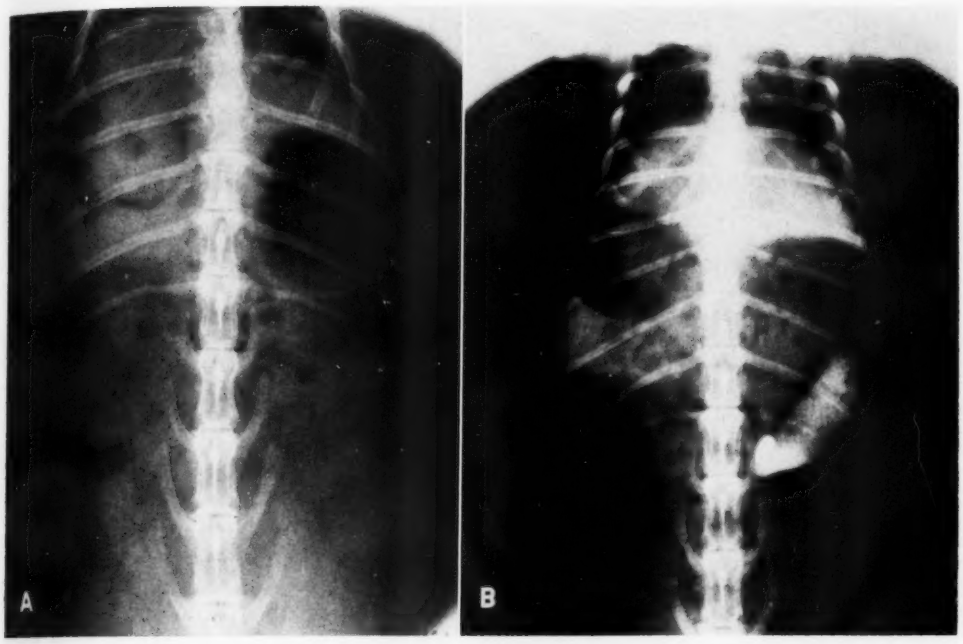

Fig. 3. A. Rabbit abdomen before injection of contrast material.
B. After an intravenous injection of colloidal thorium dioxide (Thorotrast), 1.0 c.c. per kilogram of body weight.

was not possible. Such a comparison could be made on litter mates in the same state of nutrition and health, but a comparison in which breed, weight, size, previous nutrition and health could not be controlled was not undertaken.

Films were made at all three kilovoltages in some animals, but the majority, both pre- and post-injection, were obtained at 60 kv. Postero-anterior projections were used exclusively, and in all cases films were made on the unanesthetized animal.

The selection of 60 and 80 kv, although not considered appropriate for the body thickness of small animals, was based on the commonly used technics for radiography of the human abdomen. A contrast material may show good radiopacity in small animals at low kilovoltages, but not with higher kilovoltages in larger animals. Zirconium, for example, has been noted to be as radiopaque as iodine at 40 kvp, but of inferior radiopacity at 80 kvp.

Representative films of rabbits injected with thorium dioxide and with tin dioxide are reproduced here for comparison. Figures 2A and B show the rabbit abdomen before and after injection of colloidal stannic oxide, 374 mg. of tin per kilogram of body weight. Figure 2C was obtained after a repetition of the original dose, and Figure 2D one month later. Fair shadows of liver and spleen are seen after the lower dose, and excellent shadows after the second dose. No appreciable decrease in density of the shadows is apparent after one month.

Figures 3A and B show the abdomen of a rabbit before and after injection of the recommended dose of Thorotrast. Liver and spleen are moderately well visualized. The lower dosage of stannic oxide, however, produced more or less equal shadows, while the higher doses, in each instance, produced shadows clearly superior to those obtained with Thorotrast.

The radiographs in Figure 4 were obtained with stannic oxide in doses of 688, 702, and 733 mg. per kilogram of weight. The higher dosages are as well tolerated

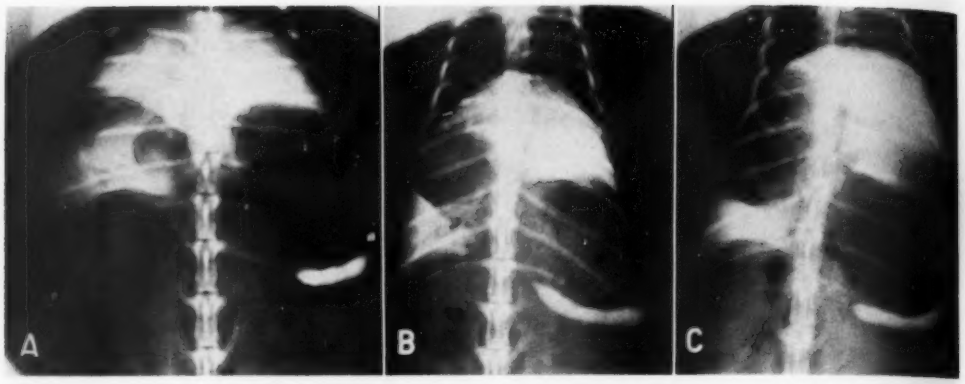

Fig. 4. Radiographs of rabbit abdomens with stannic oxide.
A. Rabbit 7, 688 mg. of Sn per kilogram of body weight. B. Rabbit 11, 702 mg./kg. C. Rabbit 12, 733 mg./kg. Excellent radiopacification of liver and spleen was obtained in all three of these animals.

as the lower. Since the colloidal tin oxide is taken up by reticulo-endothelial cells, organs which do not contain these cells in any number do not become radiopaque. The bone marrow, containing a small percentage of the total number of reticulo-endothelial cells, should show increased radiopacity, but the increment to the already pronounced radiopacity of bone is indiscernible, at least at the low dosages used in these experiments.

Fortuitously, one rabbit was noted to be pregnant after having been given 802 mg. tin per kilogram of body weight twenty days previously. Figure 5A shows the abdomen of this animal before injection, and Figure 5B after the injection. The placentae are not seen in this latter view because of their small size and immaturity in early gestation. In Figures 5C and D, however, following an additional 388 mg. dose of tin per kilogram of body weight, the mature placentae are visualized clearly. Also to be noted is the further opacification of liver and spleen, indicating that the reticulo-endothelial cells were not saturated by the prior injections of colloidal particles. Figure 5E shows the liver and spleen of this same rabbit twenty-five days after parturition.

The radiopacity of the liver and spleen appeared to reach a maximum certainly in four to six hours and possibly in as short a time as two or three hours after the rapid intravenous injection of about 350 mg. of tin, as tin oxide, per kilogram of body weight. A second dose gave maximum radiopacity in a similar length of time, even if the interval following the first dose was as short as nine hours. With each additional dose an increase in radiopacity was observed. This extended as far as a fourth dose observed in one rabbit. Once liver and spleen had obtained their maximum radiopacity within hours of injection, there was no demonstrable fading of the shadows for as long as the animals were observed (thirty days).

In two rabbits injected with colloidal stannic oxide, rather poor opacification of the liver of a spotty nature was obtained. In both animals, a diffuse involvement by coccidia was observed at autopsy. The indication of disease in the experimental animal by the impaired opacification of the liver suggests the potential diagnostic value of this contrast material in man.

II. *Selection of a Suitable Colloidal Suspension:* Colloidal suspensions of stannic oxide, SnO_2, were prepared in concentrations of 10 and 20 per cent weight/volume of tin. The particle size as determined microscopically in a counting chamber appeared not to exceed 2 microns, with most of the particles measuring 1 micron or less. The pH varied slightly above and below 7 in the different preparations. Some of the samples also

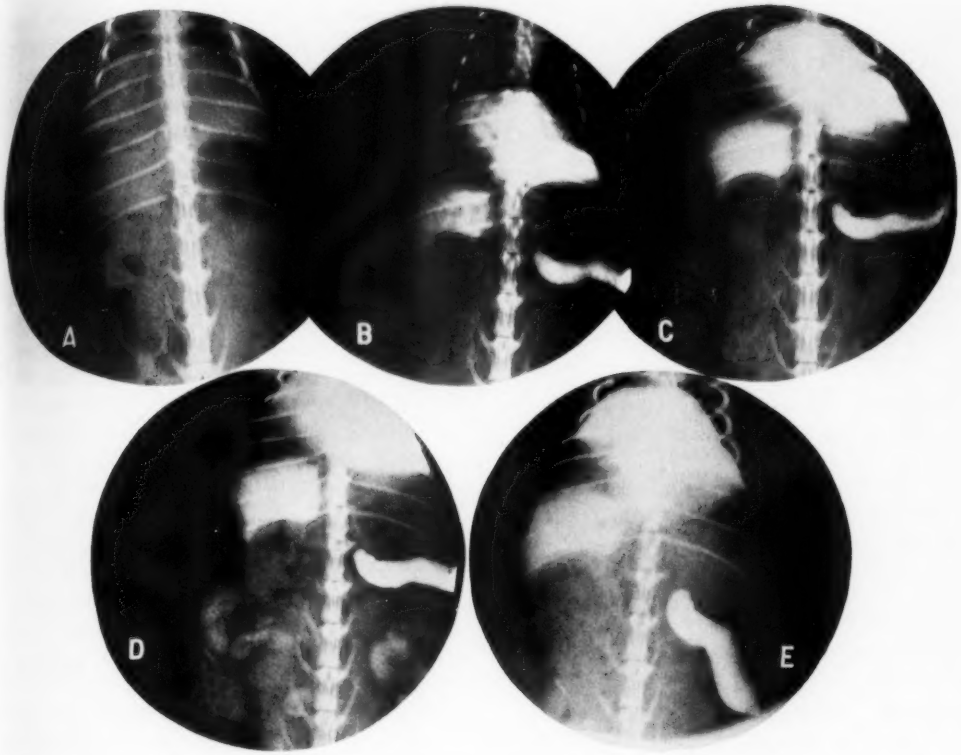

Fig. 5. A. Rabbit abdomen before injection of contrast material.
B. After intravenous injection of colloidal tin oxide, 802 mg. of tin per kilogram of body weight. Excellent shadows of liver and spleen. At the time of this film, the animal was pregnant, but placentae have not been visualized by the contrast material, since the injections were given early in gestation, when the placentae were small and immature.
C. After an additional injection of 388 mg./kg.
D. After another injection of 388 mg./kg. The mature placentae are well visualized by the contrast material. Note also the further opacification of liver and spleen, indicating that the reticuloendothelial cells of these organs were not saturated by the prior injections of colloidal particles.
E. Liver and spleen opacification twenty-five days after parturition.

contained 25 per cent sucrose. The material flowed freely and was milky white. Samples containing a preservative were used in some cases. There was no observable difference in the acute response of the animals to these slightly different preparations, nor were any differences in tissue response noted. Radiopacity of liver and spleen depends upon the amount of tin in the organs, whether this comes from a preparation of high or low tin content, and not upon minor differences in the suspensions.

III. *Toxicity of Stannic Oxide:* For evaluation of the immediate response of the animal to intravenously administered tin oxide, reference is made to Table I. Thirty-five separate doses were given by rapid intravenous injection without event, 8 separate injections being given to 4 dogs, and 27 separate injections to 13 rabbits. All injections except one were made in the unanesthetized animal. The amount of tin administered at a sitting was usually about 350 mg. per kilogram of body weight. Second doses of this magnitude were tolerated as well as the first. The usual time interval between first and second doses was twenty-four hours, but injections following as short an interval as nine hours and as long as nine days were equally uneventful.

TABLE I: EXPERIMENTAL STUDIES

Animal	Wt./kg.	Date	Injection time (minutes)	Dose mg. Sn per kg. body wt.	Dose-Time Relation mg. Sn/kg. body wt. per minute	Immediate Reaction
Rabbit						
4	3.8	6-16-55	5	374	75	none
		6-23-55	5	374	75	"
5	4.3	6-2-55	6	371	62	none
7	4.7	7-7-55	3	430	144	none
		7-8-55	2	258	129	"
8	4.0	6-16-55	4	352	88	death[1]
9	3.0	7-14-55	3	304	101	none
		7-15-55	3	325	108	"
10	3.9	7-7-55	4	414	104	none[2]
		7-8-55	4	388	97	" [2]
		7-28-55	3.5	388	111	" [3]
		7-29-55	5	388	78	" [2]
11	3.4	6-28-55	4	351	88	none
		7-8-55	4	351	88	"
12	3.4	7-7-55	4	351	88	none
		7-8-55	5	382	76	"
13	2.6	7-7-55	4	382	95	none
		7-8-55	6	421	70	"
31	2.7	7-14-56	3	370	123	none
		7-16-56	3	370	123	"
34	2.0	7-14-56	3	300	100	none
		7-16-56	3	500	167	"
35	3.5 (est.)	6-21-56	10	303	30	none
		6-22-56	..	300	..	"
		7-16-56	3	228	76	"
37	3.5 (est.)	7-14-56	3	200	67	none
		7-16-56	3	230	77	"
Dog						
16	5.9	5-12-55	10	169	17	none
		5-13-55	7	195	28	"
		5-17-55	3	169	56	"
17	8.6	5-12-55	17	261	15	none
		5-14-55	10	151	15	"
		5-16-55	5	174	35	"
18	19.1	5-19-55	13	354	27	none
19	8.6	5-26-55	10	347	35	none

Note: All rabbits were injected with a 20 per cent tin content suspension, as was Dog 19. Dogs 16, 17, and 18 were injected with a 10 per cent tin content suspension.

[1] Suspension grossly contaminated bacterially. Not considered a reaction to colloidal tin oxide.

[2] Approximately 30 days gestation.

[3] Approximately 60 days gestation.

We were familiar with the serious reactions of animals to some other colloidal solutions. These were considered to be due in large part to the formation of multiple emboli by interaction of the colloid and blood elements, causing rapidly developing and irreversible circulatory failure. This type of reaction was never observed in preliminary trials with colloidal tin oxide. A minimal number of emboli may have been formed, but there were no changes in respiratory rate; in fact, no outward sign of any kind to indicate distress or malfunction of the circulatory or respiratory system. Only one reaction was encountered, in a rabbit, whose death is felt to have been caused by a grossly contaminated preparation. This is not considered an adequate test of the contrast agent itself, since death may have been due to the microorganisms or to altered suspension stability related to bacterial metabolism. The total amount of elemental tin received was in the range of 350 to 800 mg. per kilogram of body weight, but one animal received 1,578 mg. per kilogram. These amounts are probably greater than would be required on a per weight basis in man.

During the post-injection period, the caged rabbits and dogs behaved normally in all respects. They ate well, and maintained their weights. Observations extended as long as thirty days in the rabbit,

and three months in the dog. One rabbit receiving injections while pregnant delivered a normal litter and also thrived in the postpartum period.

Gross and histologic material for study was obtained by sacrifice of the animals at various intervals (Table II). Rabbits were killed by trauma to the head and neck. Dogs were killed by an overdose of intravenous Nembutal. Autopsies were performed immediately, and tissue blocks of liver, spleen, lung, and kidney were routinely obtained and preserved in 10 per cent neutral formalin. Lung and kidney grossly appeared normal in all instances, except when blood had been aspirated *in extremis*. The liver usually showed an accentuation of the polygonal lobular pattern, especially in the animals receiving the higher doses. The retention of tin oxide in the cells was thought to change the coloration of the liver substance to a lighter shade, accounting for this pattern. There was no evidence of liver nodularity or necrosis. The spleen, also, appeared to contain whitish material. Other organs appeared grossly normal.

The microscopic studies, performed by Dr. William Platt, showed the deposition of pigmented granules in the reticulo-endothelial cells of liver and spleen. Occasionally some granules were seen in the lungs and adrenals. Very few or none were seen in the kidney and none in the pancreas. There was no evidence of cell death or toxicity, and no evidence of fibrosis in liver and spleen where the vast numbers of particles had been retained. The detailed histologic findings will be the subject of a separate report.

The evidence against chronic toxicity will be presented below.

TABLE II: SACRIFICE OF ANIMALS FOLLOWING INJECTION

Animal	Total Injected Material mg. Sn/kg. body wt.	Sacrificed (days after last injection)
Rabbit		
4	748	28
5	371	7
7	688	3
9	629	12
10	1578	27[1]
11	702	19
12	733	13
13	803	7
Dog		
16	533	70
17	586	98
18	354	70
19	347	60

[1] Sacrificed 48 days following the first series of injections of 802 mg. Sn per kg. of body weight.

DISCUSSION

Thomas (3) has succinctly listed the characteristics of an ideal hepatolienographic agent. "Such an ideal medium (*a*) should have little or no acute or chronic toxicity; (*b*) should not be radioactive; (*c*) should be of sufficiently high atomic number to afford good opacification without administration in excessive amounts; (*d*) should be administered easily, preferably orally, but intravenously if necessary; (*e*) should have a high affinity for selective deposition in the liver and spleen; (*f*) if possible, should be safely and rapidly eliminated from the body."

Intravenously administered colloidal stannic oxide has radiographically opacified the liver and spleen by reason of its selective uptake in the reticulo-endothelial cells of these two organs. Preliminary trials in rabbits and dogs have been without acute toxicity, despite rapid injection technic. To lessen the possibility of acute reactions, a slow intravenous drip method could be utilized or the total dose could be divided into two or more portions to be injected on successive days. Since a gross relationship exists between the amount of certain colloids introduced into the circulation and the incidence of reactions, either of these two methods would be preferable to rapid injection of the entire amount (11). With divided doses, radiopacity of tin oxide is cumulative. No hurry is necessary, therefore, in making the radiographs, as with the use of compounds which are more rapidly excreted.

A particle of 1 to 2 microns is to be preferred, considering available knowledge of interaction of foreign colloids and

blood and the known size of capillaries. Smaller colloidal particles in the millimicron range are more likely to give acute reactions, as evidenced by the work of Gross and Brown (12). Whether this holds true for all colloids is not known. Another advantage of the larger particle size is more rapid removal by liver and spleen. With colloidal stannic oxide preparations, maximum opacity was reached in four hours or less.

Present evidence indicates that colloidal particles introduced into the blood stream become "coated" with a protein or protein-like substance and that the coating of a particle is necessary for its phagocytosis by a liver or spleen reticulo-endothelial cell (12, 13, 14). The factors influencing coat formation, in all its complexities, and adhesiveness of the coat to the particle and to other structures, are largely uninvestigated. It is believed that the acute toxic reactions accompanying the introduction of large amounts of some types of colloids into the circulation are due to rapid coating of the particles, causing their adherence to each other and to the formed elements of the blood. Multiple embolization of capillary networks is thereby caused, particularly of the lung, leading to critical anoxia or to other situations whereby intravascular agglutination of red cells occurs, with its own serious and fatal consequences. Further investigation of this aspect of the problem of a safe colloidal contrast agent is planned.

Contrast radiography based upon the uptake of particles by phagocytic cells is subject to the fear of blockage of these cells and interference with their role in resistance to infection. The depression of phagocytic function in liver and spleen cells caused by the engulfing of many particles is transient, not permanent. Gabrielli found that the phagocytic activity of these cells was initially depressed, but later was greater than normal (15). Walker obtained similar evidence of increased ability to phagocytize, following the injection of colloids, in the lymph nodes, (16). The engulfing of one type of foreign particle does not prevent the taking in of another type at the same time or later. It is well agreed that the reticulo-endothelial system has both great capacity and great reserve. Detailed studies of possible interference with resistance to bacterial invasion and the production of antibodies by the reticulo-endothelial cells are necessary for a complete answer. The present group of experimental animals have shown no adverse effects, no increased incidence of infection, from the retention of large numbers of particles in liver and spleen cells, nor has this seemed to be a cause of difficulty in man and animals injected with other inert long-retained colloids.

Chronic toxicity is not to be expected from long retention of tin oxide. In several studies tin oxide particles in the lungs have been shown to cause no harm, even when remaining as long as forty years (17–22). Retention of tin oxide dust does not lead to toxic, allergic, or pathological changes. Reactive fibrosis, if produced, is insignificant. Among 121 men who had inhaled massive amounts of tin oxide dust in the mining industry, Robertson and Whitaker (17) found no case of progressive massive fibrosis, no evidence of disability, nor any complicating features. Dundon and Hughes, in their case of stannic oxide pneumoconiosis, found unequivocal proof of widespread deposition of tin oxide in pulmonary lymphatics without any special fibrous reaction (18). The extent of involvement of the lung fields by tin oxide as shown by chest radiographs leaves little doubt that sufficient opportunity for pathologic changes has been afforded, yet no tissue has been destroyed, and no physiologic embarrassment has arisen.

The fact that retention of tin oxide in the lungs has resulted in no harm does not necessarily insure its equal benignancy when it is retained in liver and spleen phagocytes, although the cell type is considered essentially the same. Absence of pathological change in lung phagocytes and the presence of such changes in similar cells located elsewhere, though unlikely,

might occur. Silica, however, when injected intravenously and accumulated in liver and spleen, causes fibrosis and cell damage identical with that in the lungs following inhalation. We would expect, on this basis, that lung and liver-spleen reactions from tin oxide would be the same. More conclusive is the lack of damage seen in our short-term studies of the rabbit (thirty days) and dog (ninety days), and in Robertson's failure to find any tissue reaction in animal studies carried on for as long as a year (23).

The insolubility and inertness of tin oxides are advantages as well as disadvantages. An excretable compound is much to be preferred, but if this is not possible, at least for the present, a completely inert compound is an asset. Completely insoluble material causing no reaction has long been valued by surgeons for permanent use in the body. Hahn finds insolubility in body fluids an advantage for a deposited metal, for there is no production of untoward tissue or sensitization reactions (24). Unsuccessful attempts to remove thorium dioxide from the body by administration of detoxifying agents (BAL) indicate that similar efforts at removing tin oxide would also fail (25).

Tin has an additional advantage not possessed by most other heavy metals. Should it in some way be slowly dissolved, toxicity would not be expected from its soluble form, since ionic tin is ingested daily by modern man without adverse effect. The average diet of the American man contains 17 mg. of tin per day, and much larger amounts can be tolerated (26, 27).

Tin oxide is not radioactive.

SUMMARY

Early animal studies of the radiopacity and toxicity of a new hepatolienographic agent, colloidal stannic oxide, are described. Colloidal tin oxide fulfills well the criteria for an ideal contrast material for radiographic visualization of liver and spleen, and possibly of the placenta, except for long retention of the agent in the body.

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SUMMARIO IN INTERLINGUA

Colloide Oxydo Stannic: Studios Animal in Re Un Nove Agente Hepatolienographic

In experimentos con canes e conilios, colloide oxydo stannic se monstrava qualificate a satisfacer le majoritate del criterios de un ideal substantia de contrasto pro le demonstration de hepate e splen. Su radio-opacitate esseva ben comparabile con illo obtenite per Thorotrast e se distingueva per su potentia cumulative con injectiones repetite. Quando le hepate e le splen habeva attingite lor radio-opacitate maximal (duo a sex horas post le injection), il occurreva nulle demonstrabile dilution del umbras durante le integre periodo de observation (trenta dies).

Nulle effectos toxic attribuibile al medio usate esseva observate. Isto es de accordo con le investigationes del toxicitate de oxydo stannic per altere autores. In un conilio, in que pregnantia esseva constatate post le dose initial, studios sequente le secunde injection gaudeva de un visualisation clar del placentas.

Secundo le stato presente del cognoscentias, le elimination de oxydo stannic ab le corpore es apparentemente impossibile, sed su retention in le cellulas reticuloendothelial del hepate e del splen pare esser sin effecto adverse.

Venography in Superior Vena Caval Obstruction[1]

GRANVILLE W. HUDSON, M.D.

VENOGRAPHY provides radiographic visualization of the superior vena caval system and offers a reliable means of obtaining precise information regarding the anatomical site and degree of obstruction in lesions of these veins. The procedure also demonstrates the pattern and extent of the collateral channel formation around sites of obstruction in the superior vena cava. McCord, Edlin, and Block (14) have observed that in the last two decades, following the introduction of contrast studies of blood vessels and use of venous pressure technics, there has been progressive development in our knowledge of lesions of the superior vena caval system. Hinshaw and Rutledge (10) have stressed the desirability of localizing the site of obstruction accurately if surgical treatment is contemplated.

ANATOMICAL FEATURES

The superior vena cava returns the blood from the head, neck, upper extremities, thoracic wall, and part of the upper abdominal wall. This great vein, measuring approximately 70 mm. in length, is formed by the union of the two innominate veins. It is enclosed within the fibrous layer of the pericardium in the lower half of its extent and terminates in the upper and posterior part of the right atrium. Near the upper end, the azygos vein contributes blood from the thoracic wall. This latter vein is the one large tributary received by the superior vena cava. The azygos vein is not actually an unpaired vein, since there is a corresponding structure on the left side, the hemiazygos vein, which is smaller than the azygos and empties blood either partly or completely into it.

McIntire and Sykes (15) emphasize the anatomical significance of the two very important chains of lymph nodes that encircle the superior vena cava. These groups of nodes, the right anterior mediastinal and the right laterotracheal chains, as well as the right bronchial nodes and some of the nodes of the tracheal bifurcation, are in close association with the vessel. Most of the structures of the right thoracic cavity, the mediastinum, and part of the structures of the left thoracic cavity drain into the lymph nodes closely related to the superior vena cava. Inflammatory or neoplastic disease in this part of the mediastinum or thorax offers a constant threat to these lymphatic chains, with possible obstruction of the superior vena cava from actual invasion or extrinsic pressure.

The anterior and posterior boundaries of the superior mediastinum, through which the superior vena cava passes, are rigid parts of the thoracic wall. The lateral boundaries are rather elastic, being formed by the pliable pleural layers. These factors permit space-occupying lesions to expand laterally. Hinshaw and Rutledge have emphasized that the great veins are thin-walled, and that the blood flowing through them is under low pressure. These major channels are, therefore, readily compressed by expanding mediastinal lesions, with resulting obstruction to the flow of blood, producing localized signs and symptoms indicative of a mediastinal lesion.

SYMPTOMATOLOGY AND CLINICAL FEATURES

When the superior vena cava is occluded, a marked increase in the venous pressure in the upper half of the body occurs, producing a characteristic clinical picture of edema in the face, neck, and upper extremities. This edema may be intermittent at first, and is aggravated in the recumbent position and on stooping or bending forward. Cyanosis and suffusion of the

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face may be a prominent feature. There may be associated dyspnea, headache, vertigo, somnolence, deafness, and tinnitus. Headache and chest pain are occasionally troublesome. The objective manifestations of superior vena caval obstruction are increased venous pressure, collateral diversion of the blood stream, and delayed circulation time.

ETIOLOGY

Superior vena caval obstruction may be caused by a variety of mediastinal abnormalities. Hussey, Katz, and Yater (11) described 35 cases of obstruction, with neoplasms present in 43 per cent. Roberts, Dotter, and Steinberg (17) reported a series of 55 cases, of which 78 per cent were due to tumor. The more common tumors involving this region are: bronchogenic carcinoma, malignant lymphoma, mediastinal fibrosarcoma, carcinoma of the mediastinal nodes metastatic from the breast, thyroid, and pancreas.

McIntire and Sykes reviewed 502 cases of superior vena caval obstruction from the literature and found primary malignant tumors responsible for 33.3 per cent. Approximately 80 per cent of the cases of obstruction in their survey were due to primary malignant thoracic tumors, aneurysms, or chronic fibrous mediastinitis. Chronic mediastinitis is given by these authors as the cause of obstruction in 24.8 per cent of a series of 250 cases. Approximately 25 per cent of the cases of chronic mediastinitis in this group were of an anatomic type best described as chronic fibrous mediastinitis. According to Erganian and Wade (6), the findings in chronic fibrous mediastinitis consist of a poorly defined mass in the superior mediastinum, composed of dense collagenous tissue with foci of infiltration with leukocytes and calcification. The exact etiologic factors are not known, but it seems likely that mild mediastinal inflammation in an individual with a tendency to excessive cicatrization may allow the slowly progressive formation of a mass of dense fibrous tissue.

McIntire and Sykes report a total of 19 cases of superior vena caval occlusion due to thrombus formation. In comparison with previous reports their survey shows a marked drop in the incidence of chronic syphilitic mediastinitis and a decline in the occurrence of chronic tuberculous mediastinitis.

Gray and Skinner (8) have observed that superior vena caval obstruction occurs twice as frequently in males as in females. The highest incidence is between thirty and sixty years, corresponding to the age incidence of the common etiologic factors.

COLLATERAL CIRCULATION

When the major venous trunks or their tributaries become obstructed, either by extrinsic pressure or invasion, an elaborate collateral venous system assumes the burden of returning venous blood to the right heart from the head, neck, upper extremities, and upper thorax. Experimental studies by Carlson (4) have contributed greatly to the understanding and identification of the collateral pathways. There are four important collateral routes for carrying venous blood around an obstruction and back to the right heart. They comprise the azygos, internal mammary, vertebral, and lateral shoracic systems. These systems are illustrated by a schematic drawing (Fig. 1). All four routes are interconnected and are concerned in the collateral circulation, regardless of whether the obstruction is above, below, or involves the orifice of the azygos vein. The level of the obstruction, in relation to the orifice of the azygos vein, indicates, however, which route will predominate. McIntire and Sykes have described in detail the complex collateral circulation in obstruction of the superior vena cava.

The *azygos route*, which includes the azygos, hemiazygos, accessory azygos, ascending lumbar, and lumbar veins, is an extremely important pathway of communication between the superior and inferior vena cava and receives some of the blood from the internal mammary and vertebral routes. The level of the obstruction in relation to the orifice of the azygos vein

determines the importance of this route and the direction of blood flow. When the superior vena cava is obstructed above the azygos orifice, the major flow is from a dilated azygos venous system forming an extremely important channel in returning blood must return to the heart through the inferior vena cava.

Kampmeier (12) has graphically illustrated the anatomical features of obstruction involving the superior vena cava as the result of a thrombus below the level of

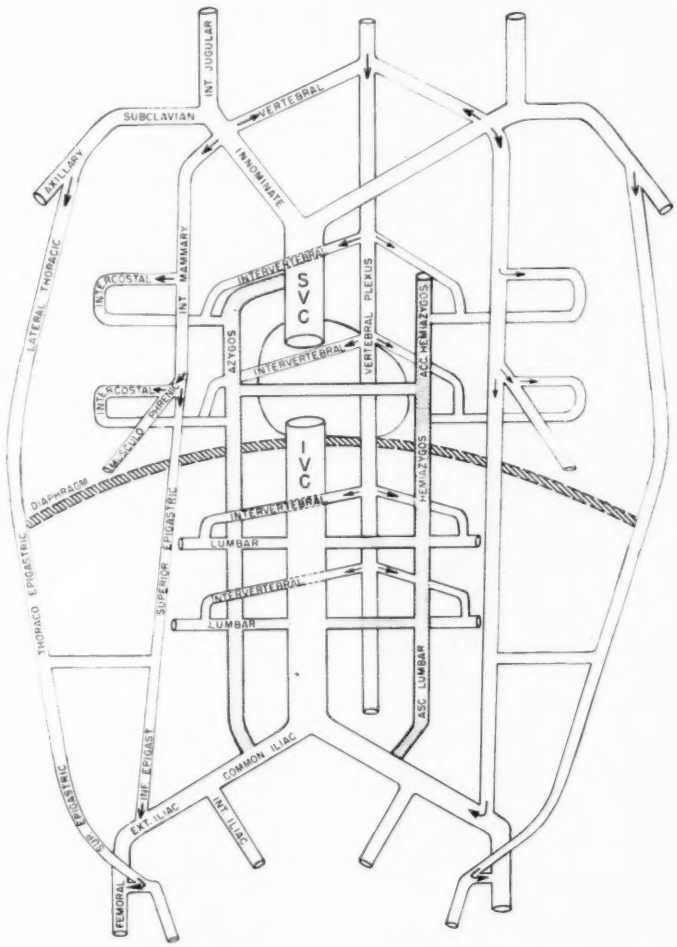

Fig. 1. Schematic representation of venous collateral systems in obstruction of the superior vena cava: azygos, vertebral, internal mammary and lateral thoracic. Adapted from McIntire and Sykes (15).

blood to the heart. When the obstruction involves the orifice of the azygos vein, the blood flow is apparently reversed and the vein is reduced in size (Carlson). If the entire superior vena caval system, including the azygos tributaries, is obstructed, the orifice of the azygos vein, leading to extensive modification in the course and direction of the venous flow from the upper parts of the body to the heart. These changes are briefly summarized as follows: All blood returning to the heart from above

the diaphragm, except that from the coronary veins, was forced to descend to the abdominal cavity, where it discharged into the inferior vena cava. The direction of the blood stream in the azygos system of veins was the exact reverse of that in the normal system.

The *internal mammary route* consists of the internal mammary vein, the superior and inferior epigastric, the musculophrenic veins, and the intercostal veins, with the exception of the first right and upper three left intercostals. The anterior and posterior superficial veins of the thorax, the perforating branches of the internal mammary vein, and the medial mammary and posterior rami of the intercostal veins also participate. This route receives part of the blood draining from the vertebral route. Blood from the internal mammary pathway ultimately empties into the azygos veins and external iliac veins.

The *vertebral route* consists of the vertebral and intervertebral veins and the external and internal vertebral plexuses. It carries blood from the innominate veins and the dural sinuses to the intercostal, lumbar, and sacral veins. The drainage is partially into the internal mammary route and partially into the azygos system. Carlson refers to the importance of this pathway when the azygos vein is obstructed.

The *lateral thoracic route* consists of the lateral thoracic, thoraco-epigastric, superficial epigastric, and superficial circumflex iliac veins. Their contained blood is poured into the femoral vein through the long saphenous vein (McIntire and Sykes). These veins are superficial and, when dilated, can be readily observed. When the dilatation is a result of superior vena caval obstruction, the direction of blood flow is downward. This pathway is prominent in the presence of obstruction of the orifice of the azygos vein (Carlson); it communicates freely with the internal mammary route.

RADIOGRAPHIC FEATURES

Conventional radiographs of the chest offer a limited degree of information concerning the superior vena caval system. In the postero-anterior projection, the right upper mediastinal border is formed by the superior vena cava and right innominate veins. The former blends inferiorly into the right upper atrial shadow.

Venography can determine the location and nature of obstruction involving the superior vena caval system, as well as the extent of the collateral circulation around the site of occlusion. Venograms establish anatomic details that could otherwise be provided only by dissection.

For venography in this series a rapid cassette changer that allowed films to be obtained at intervals of one second was utilized. Rapid injection of 30 to 35 c.c. of either 70 per cent Diodrast, Urokon or Neo-Iopax was made into a suitable vein in one arm, and serial films were obtained. The first film was exposed toward the end of the injection. With this technic, the great venous system and the collateral pathways around obstruction sites may be visualized.

Reports of 2 cases in which venography was employed follow.

CASE REPORTS

CASE I: A 53-year-old white female gave a four-month history of edema of the head and neck, aggravated by flexion of the body. Physical examination revealed edema of the face, neck, and arms and increased filling of the veins of the upper extremities and neck. Venous pressure in the upper extremities was 250 mm. of saline, as compared with 48 mm. in the lower extremities. Circulation time, arm-to-tongue, was seventeen seconds.

Venographic Features (Fig. 2): The venograms show a large filling defect involving the medial aspect of the superior vena cava. The inferior thyroid vein is markedly dilated. The azygos and hemiazygos veins are also greatly dilated and the course of the blood stream is retrograde to a level below the diaphragm, where it is ultimately discharged into the inferior vena cava. The lower intercostal veins adjacent to the azygos and hemiazygos system are dilated. Anastomoses carrying collateral blood from the ascending lumbars of the azygos system, the vertebral plexuses, the lumbar veins, and the inferior vena cava are shown. The two- and three-second films show an opacified inferior vena cava. An opaque right atrium is apparent at three seconds.

Exploration of the right thorax revealed a hard, nodular tumor in the anterior medial portion of the

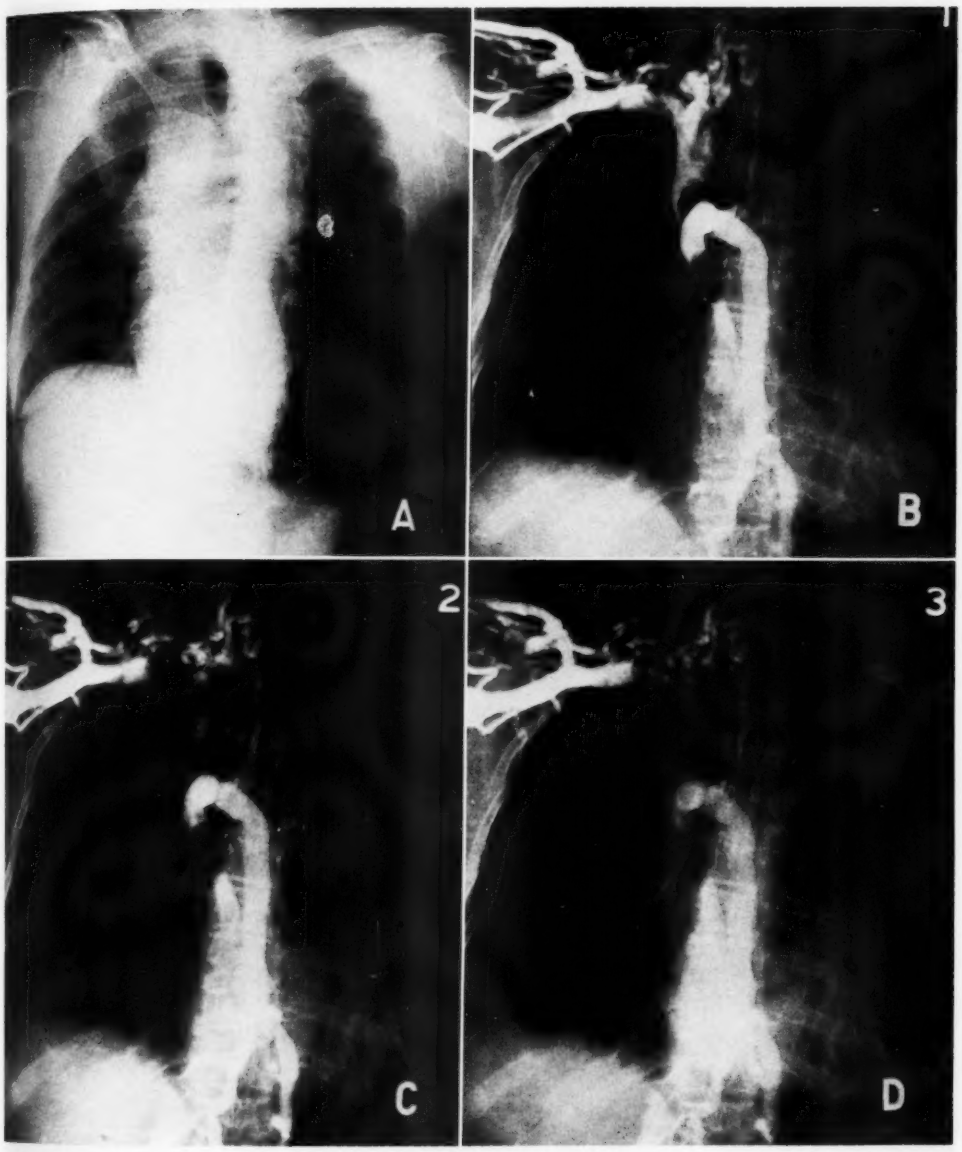

Fig. 2. A. Oblique roentgenogram of chest, showing large right paramediastinal mass.
B. Venogram at one second, showing a filling defect in the superior vena cava with the azygos system filled by retrograde venous flow.
C. Film at two seconds, showing filled azygos system, opacification of the inferior vena cava, and elaborate anastomotic venous plexus below the diaphragm.
D. Film at three seconds, showing filling of the azygos route and the inferior vena cava, and opacification of the right atrium.

right upper lobe, which was continuous with a large nodular fixed mass in the mediastinum. This mass extended posteriorly to encircle the superior vena cava just above the base of the heart.

Final Clinical Diagnosis: Adenocarcinoma of the bronchus with secondary adenocarcinoma of the mediastinum and superior vena caval obstruction.

CASE II: A 16-year-old white male was seen with an eighteen-month history of bluish discoloration of

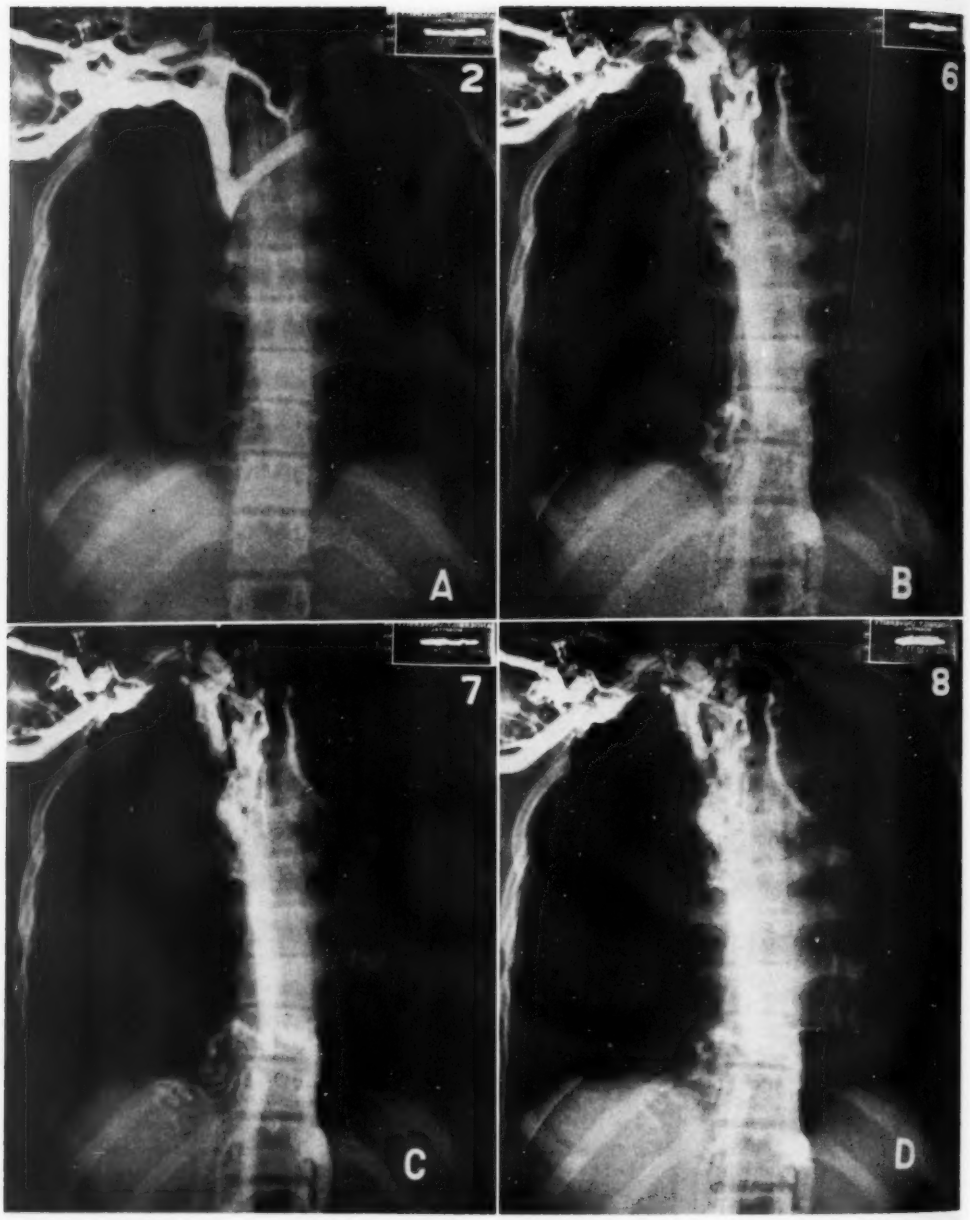

Fig. 3. A. Venogram at two seconds. Both innominate veins are filled. There is a constrictive lesion in the upper superior vena cava.

B. Venogram at six seconds, showing retrograde filling of the azygos and hemiazygos route. The internal mammary vein and the inferior vena cava are opacified.

C. Film at seven seconds. The azygos and hemiazygos venous pathways are filled and the inferior vena cava is opacified. There is an extensive venous collateral network below the diaphragm.

D. Film at eight seconds. The azygos venous circulation remains opaque, as well as the inferior vena cava and collateral anastomoses.

the face and neck on exercise, associated with dyspnea and slight dizziness. These symptoms had gradually increased in severity. Physical examination revealed moderate distention of the veins of the face and neck.

Venographic Aspects (Fig. 3): The right and left innominate veins are filled, and obstruction involving the upper part of the superior vena cava is apparent. Films at 6, 7, and 8 seconds show dilated right superior intercostal, inferior thyroid, and internal mammary veins. The azygos and hemiazygos veins are dilated, and the blood stream takes a retrograde route through this system. An elaborate communicating network can be seen, utilizing the lumbar veins, the lower intercostal veins, and the ascending lumbars of the azygos system, which drain the blood into the inferior vena cava.

Exploration: The mediastinum was explored and the azygos vein and superior intercostals were found to be tremendously dilated. The flow of blood through the azygos veins seemed to be downward. A hard, nodular mass measuring 8 × 4 × 4 cm. was felt in the mediastinum in the region of the lower end of the trachea and the base of the heart. Both right and left innominate veins, along with the superior vena cava, appeared much smaller than normal. The superior vena cava seemed to be completely obliterated in this mass.

Final Clinical Diagnosis: Superior vena caval occlusion due to an encircling cicatrix which was thought to have resulted from an old tuberculous adenitis.

SUMMARY

Venography was utilized to study lesions producing obstruction in the superior vena caval system. The site and degree of venous obstruction and the extent of the collateral circulation around the block may be determined by this radiographic procedure.

Two illustrative cases are reported. In one, occlusion was due to an encircling cicatrix thought to have resulted from an old tuberculous adenitis. Adenocarcinoma of the bronchus with secondary involvement of the mediastinum was responsible for obstruction in the other.

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(Pro le summario in interlingua, vider le pagina sequente.)

SUMMARIO IN INTERLINGUA

Venographia in Obstruction de Vena Cave Superior

Venographia provide visualisation radiographic del systema del vena cave superior e representa un methodo fidel pro obtener exacte informationes in re le sito anatomic e le grado de obstruction de iste vaso e pro demonstrar le configuration e le extension del circulation collateral per que sanguine venose es retornate al corde dextere veniente ab capite, collo, extremitates superior, e thorace superior. Detalios alteremente establibile solmente per dissection es assi establite per medios venographic.

Duo casos de obstruction del vena cave es reportate con illustrative constatationes venographic. In un de iste casos le occlusion esseva le effecto de un cicatrice incirculante que esseva interpretate como resultato de un ancian adenitis tuberculotic. In le altere caso un adenocarcinoma mediastinal secundari a adenocarcinoma del broncho esseva responsabile pro le obstruction.

The Intravenous Cholangiographic Diagnosis of Partial Obstruction of the Common Bile Duct[1]

ROBERT E. WISE, M.D., DAVID O. JOHNSTON, M.D., and FERDINAND A. SALZMAN, M.D.

IN AN ATTEMPT to evaluate the role of intravenous cholangiography in the diagnosis of partial obstruction of the common bile duct, to determine the relationship of common duct size to partial obstructions of the duct, and to establish criteria for roentgenographic diagnosis, we have reviewed our experiences of the past two and one-half years. Since a significant number of postcholecystectomy patients either exhibit the same symptoms as before operation or develop new symptoms, the problem is worthy of attention. The implications are: (*a*) that the gallbladder disease was not responsible for the precholecystectomy complaints, (*b*) that the surgical procedure was incomplete and should have gone beyond simple removal of the gallbladder and at times beyond removal of common duct calculi, or (*c*) that mechanical or inflammatory injury to the common bile duct may have taken place at the time of or shortly after cholecystectomy.

Walters (1) in 1956, was of the opinion that the most frequent causes of pain after cholecystectomy are overlooked common duct calculi, stricture of the bile ducts, gallbladder remnants with or without stones, inflamed or calcareous elongated cystic duct remnants, malfunction of the sphincter of Oddi, pancreatitis, intra-abdominal ulcer or neoplasm and retroperitoneal lesions.

It is well recognized that residual common duct calculi account for a high percentage of postcholecystectomy pain. Intravenous cholangiography has been most widely used in the search for these calculi. Meagher and Campbell (2), in a review of cholecystitis at Boston City Hospital from 1951 to 1953, found the incidence of common duct calculi, mud, or sludge, to be 43.2 per cent in chronic cholecystitis and 30 per cent in acute cholecystitis. Colcock and McManus (3) and Adams and Stranahan (4) reported a total of 2,460 patients operated upon at the Lahey Clinic for gallbladder disease with an incidence of common duct calculi of 16.8 per cent between 1941 and 1945 and 10.4 per cent between 1950 and 1953, or an overall incidence of 13.3 per cent. In a review of 1,356 patients, Colcock and McManus found 5 with common duct calculi but no associated stones in the gallbladder.

In a recent review of 153 cases of choledocholithiasis, followed for periods of two to twelve years, Johnston, Waugh, and Good (5) reported the occurrence of residual calculi in approximately 8 per cent.

Snodgrass, quoted by Preston (6), remarked that the chief purpose of exploration of the common bile duct in most reported series has been to detect and remove stones. Such procedures, he believed, may be followed by the persistence of disabling postoperative symptoms when coexisting stenosis or fibrotic stricture at the sphincter of Oddi is overlooked or remains uncorrected. Thus, a good result could not be expected from cholecystectomy alone.

In two separate series Cattell *et al.* (7,8) reviewed their results in a total of 151 cases of fibrosis of the sphincter of Oddi in which either manual dilatations or transduodenal sphincterotomies were carried out, and reported relief of symptoms in between 80 and 90 per cent.

In an analysis of postoperative strictures of the bile ducts, Donaldson, Allen, and Bartlett (9) showed that in 87 cases, 62 strictures followed cholecystectomy, 19 followed cholecystectomy and choledo-

[1] From the Department of Radiology, The Lahey Clinic, and The New England Baptist Hospital, Boston, Mass. Presented at the Forty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2-7, 1956.

chostomy, 3 followed gastrectomy, 1 followed portacaval shunt, and 2 were nonoperative in origin. They attributed 37 per cent of strictures occurring after cholecystectomy to proved operative trauma. In the remaining 63 per cent a considerable number were due to gross injury; at least a small percentage were the result of the intensity of the original infection, and accumulation of bile adjacent to the common duct accounted for some. Cole, Ireneus, and Reynolds (10) stated that 66.3 per cent of 92 benign strictures in their series were the result of operative trauma and 22.5 per cent were thought to be secondary to inflammation.

It is thus apparent that the problem of the symptomatic postcholecystectomy patient is a complex one. The foregoing suggests that a significant number of these patients probably suffer from disease overlooked at the time of operation or, still worse, from iatrogenic disease.

Many of these conditions produce symptoms because of their obstructive effect. Many, in the earlier stages, cause only partial obstruction and do not greatly affect grossly accurate liver function studies; yet they may be symptomatic It would be as logical to ignore partial obstructions of the urinary tract until they produced complete obstruction or the equivalent of jaundice as to ignore partial obstructions of the biliary passages.

We must then go beyond a mere search for common duct calculi and consider the many other symptomatogenic pathologic conditions affecting the common bile duct if as many patients as possible are to be offered the prospect of surgical relief of their symptoms. If the organic causes of postcholecystectomy pain can be accurately excluded, attention may then be directed to a probable functional background—a problem presented by a high percentage of patients with postcholecystectomy pain.

The problem of the radiologist, therefore, is twofold: first, and most obviously, he must be concerned with complete preoperative diagnosis with respect to both the gallbladder and the biliary passages; second, he must be concerned with accurate postoperative diagnosis in the symptomatic patient.

TABLE I: INCIDENCE OF VISUALIZATION

Injections (770)	
With visualization of ducts	662 (85.9%)
Patients (746)	
With visualization of ducts	638 (85.5%)
Precholecystectomy group (256)	
Injections with visualization	230
Patients with visualization	228 (89.0%)
Postcholecystectomy group (490)	
Injections with visualization	432
Patients with visualization	410 (83.6%)

The present study covers a series of 770 injections administered to 746 patients and includes our initial experiences, which have been previously reported (11–15). Of 256 patients examined before cholecystectomy, visualization was obtained in 228, while of the 490 who had previously undergone cholecystectomy, visualization was obtained in 410. It is with the two groups in which visualization was achieved that we are concerned in this analysis. Of the 228 precholecystectomy patients, 77 underwent cholecystectomy and of the 410 postcholecystectomy patients, 80 underwent subsequent surgical procedures on the biliary system, bringing the total of operated cases to 157.

VISUALIZATION

The incidence of visualization of the biliary passages following injection of Cholografin is of little value unless criteria for the selection of patients are stated. If laboratory studies are available, we usually do not attempt the examination in the presence of a serum bilirubin value of over 4 mg. per 100 c.c. or a bromsulphalein retention of over 40 per cent. In the absence of these studies, we do not, as a rule, inject the compound in the presence of clinical jaundice. In our group of 746 patients, some degree of visualization of the bile ducts was obtained in 638, or 85.5 per cent. The incidence of visualization in the subgroups is shown in Table I.

TECHNIC OF EXAMINATION

Our present technic does not differ greatly from that previously described

(14), the only change being that we now use 20 c.c. of 52 per cent Cholografin methylglucamine routinely. The patient is examined in a fasting state. In all cases in which the gallbladder is visualized, right lateral decubitus views are made to exclude or confirm the presence of gallstones. For evaluation of the common bile duct, the study is usually carried to two hours, roentgenograms being obtained at fifteen- to twenty-minute intervals with adjustments of radiographic technic and position as required. Morphine is not employed, since it produces a pharmacologic obstruction and precludes evaluation of possible organic obstruction. Frequent use is made of body-section radiography in a search for common duct calculi.

REACTIONS

In our first series (14), the reaction rate was 11.3 per cent. An accurate account of side effects has not been kept in this series, but we have no reason to believe that it has increased. Skin testing has been of no value in predicting reactions. We have encountered no fatalities, and none have been reported to the manufacturers (16).

COMMON DUCT SIZE

In 100 patients in whom the gallbladder was intact, excellent visualization of both the gallbladder and common duct was obtained. In these cases there was no radiographic evidence of calculi and the gallbladder was regarded as normal. The common duct in this group ranged in diameter from 2 to 20 mm., yielding a presumptive normal average diameter of 5.6 mm. Thirteen of these patients underwent biliary surgery for various reasons (dilated common duct in 2, question of pancreatitis, or unexplained pain), with common duct explorations in 8. Three partial obstructions of the distal common duct were found, due, respectively, to carcinoma of the head of the pancreas, fibrosis of the ampulla of Vater, and carcinoma of the distal common duct. One of these cases is shown in Figure 1. The

Fig. 1. A 20 mm. common bile duct. Note visualization of the gallbladder. Bromsulphalein retention 6 per cent. Serum bilirubin 0.6 mg. per 100 c.c. Gross dilatation of common bile duct is indicative of partial obstruction of unknown etiology. Surgical exploration revealed carcinoma originating in the distal common duct.

cholangiographic measurements of the common duct in the 3 cases were 9 mm., 12 mm., and 20 mm. One case of cholelithiasis and choledocholithiasis in which the common duct diameter was 5 mm. was also found. With the exclusion of these 4 patients from the series, the average diameter of the common bile duct in the presumably normal case is 5.5. mm. with a range of 2 to 14 mm., uncorrected for magnification (Table II, Group 1). This figure is in agreement with that of Shehadi (17), who gave 5 to 6 mm. as the diameter of the normal common duct. McClenahan *et al.* (18) considered 7 mm. to be the upper limit of normal. It is impossible to set an absolute figure for normal size, as illustrated in the present series, with its range of 2 to 14 mm. It is of interest that in 2 cases with partial obstruction due to carcinoma, there was an associated distention of the gallbladder and the common duct had assumed a tubular shape rather than the usual tapered one.

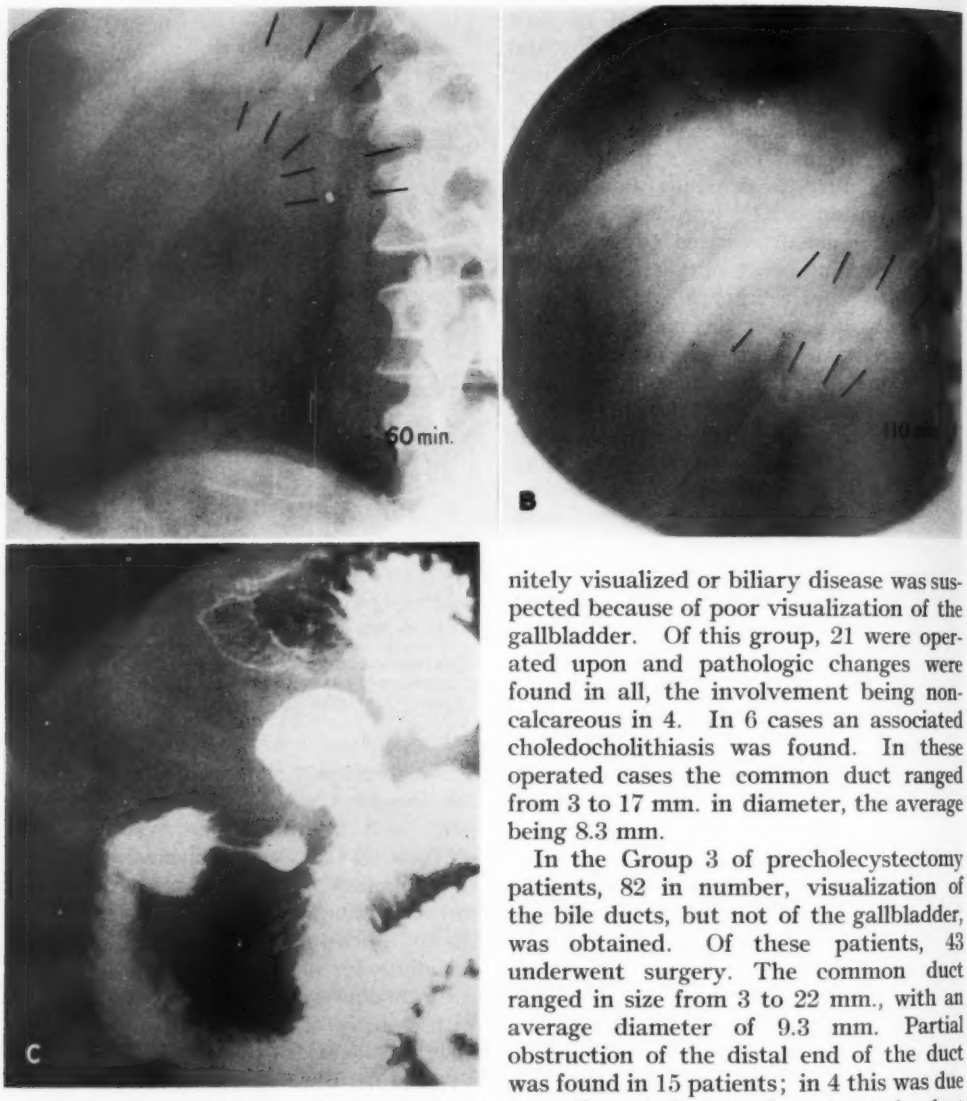

Fig. 2. The gallbladder is intact but not visualized with Cholografin. Common bile duct measures 12 mm. Abnormal retention, shown on 60- and 110-minute films (A and B), is indicative of partial obstruction. Results of gastrointestinal examination (C) were considered negative. Bromsulphalein retention 10 per cent. Serum bilirubin 0.2 mg. per 100 c.c. Surgical exploration revealed carcinoma of the head of the pancreas. The common duct and gallbladder were found to be distended.

The remaining precholecystectomy patients have been divided into two groups for study purposes (Table II). In Group 2, numbering 45 cases, gallstones were definitely visualized or biliary disease was suspected because of poor visualization of the gallbladder. Of this group, 21 were operated upon and pathologic changes were found in all, the involvement being noncalcareous in 4. In 6 cases an associated choledocholithiasis was found. In these operated cases the common duct ranged from 3 to 17 mm. in diameter, the average being 8.3 mm.

In the Group 3 of precholecystectomy patients, 82 in number, visualization of the bile ducts, but not of the gallbladder, was obtained. Of these patients, 43 underwent surgery. The common duct ranged in size from 3 to 22 mm., with an average diameter of 9.3 mm. Partial obstruction of the distal end of the duct was found in 15 patients; in 4 this was due to malignant disease of or about the duct (Figs. 2 and 3), in 3 to calculi (Fig. 7), and in 8 to fibrosis of the ampulla of Vater or sphincter of Oddi, as in Figure 4. It is of interest to compare the previous group (Group 2, Table II) in which some visualization of the gallbladder was obtained with this latter group (Group 3, Table II) in which it was not visualized. In Group 2, a lesser degree of gallbladder disease is suggested, since the gallbladder was found to be of essentially normal size and not

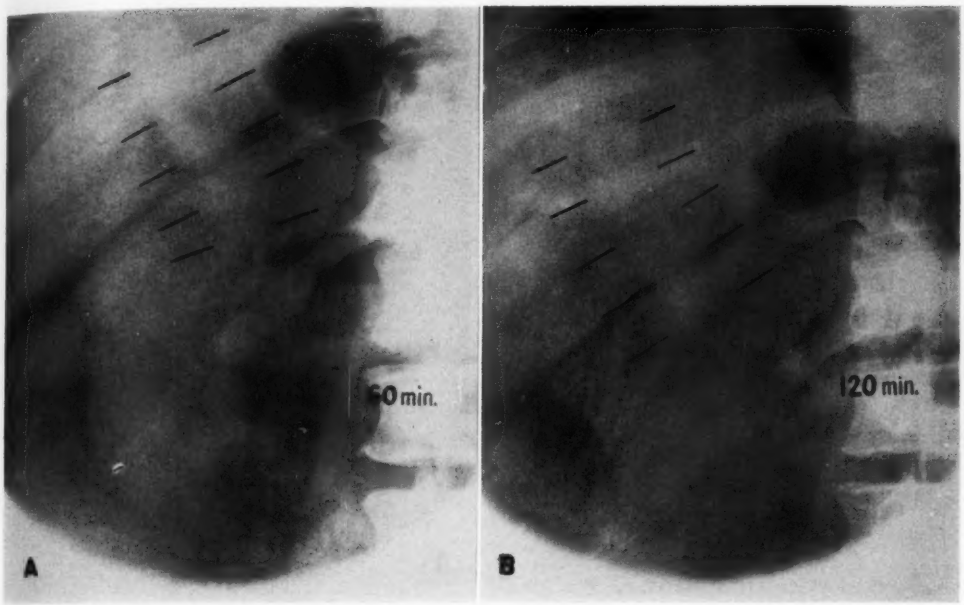

Fig. 3. Gallbladder is intact but not visualized with Cholografin. There is presumptive evidence of cystic duct obstruction. At 60 minutes (A) the common duct is well visualized and shows no evidence of calculus. At 120 minutes (B) Cholografin-stained bile is abnormally retained, indicating partial obstruction of unknown etiology. Common duct measures 18 mm. Surgical exploration revealed malignant carcinoid of the ampulla of Vater as the cause of the partial obstruction of the common bile duct.

TABLE II: COMMON DUCT SIZE

Group	No.	Diameter	
		Range (mm.)	Average (mm.)
1. Precholecystectomy Visualization of bile ducts and gallbladder (proved abnormalities excluded)	96	2 to 14	5.5
2. Precholecystectomy Poor visualization of gallbladder and/or gallstones Common duct visualized	45 (21 operated)	3 to 17	8.3
3. Precholecystectomy No visualization of gallbladder Common duct visualized	82 (43 operated)	3 to 22	9.3
4. Operated patients of Groups 2 and 3 combined (with proved gallbladder pathology)	64	3 to 22	9.0
5. Postcholecystectomy Visualization of common duct (immeasurable ducts excluded)	397	3 to 30	9.1

contracted with fibrosis (none were found to be so at surgery). In Group 3 gallbladder disease generally was more severe (10 patients were found to have small contracted fibrotic gallbladders) and presumably of a more chronic nature. It is only in this latter group that any cases of fibrosis of the sphincter of Oddi or ampulla were found (common duct size 10 to 18 mm.). In Group 2 common duct calculi only were detected. This strongly suggests a relationship between severe chronic disease of the gallbladder and fibrosis of the distal common duct and indicates that it is the most common cause of dilatation of the common duct in the absence of visualization of the gallbladder. In this particular group cancer was the

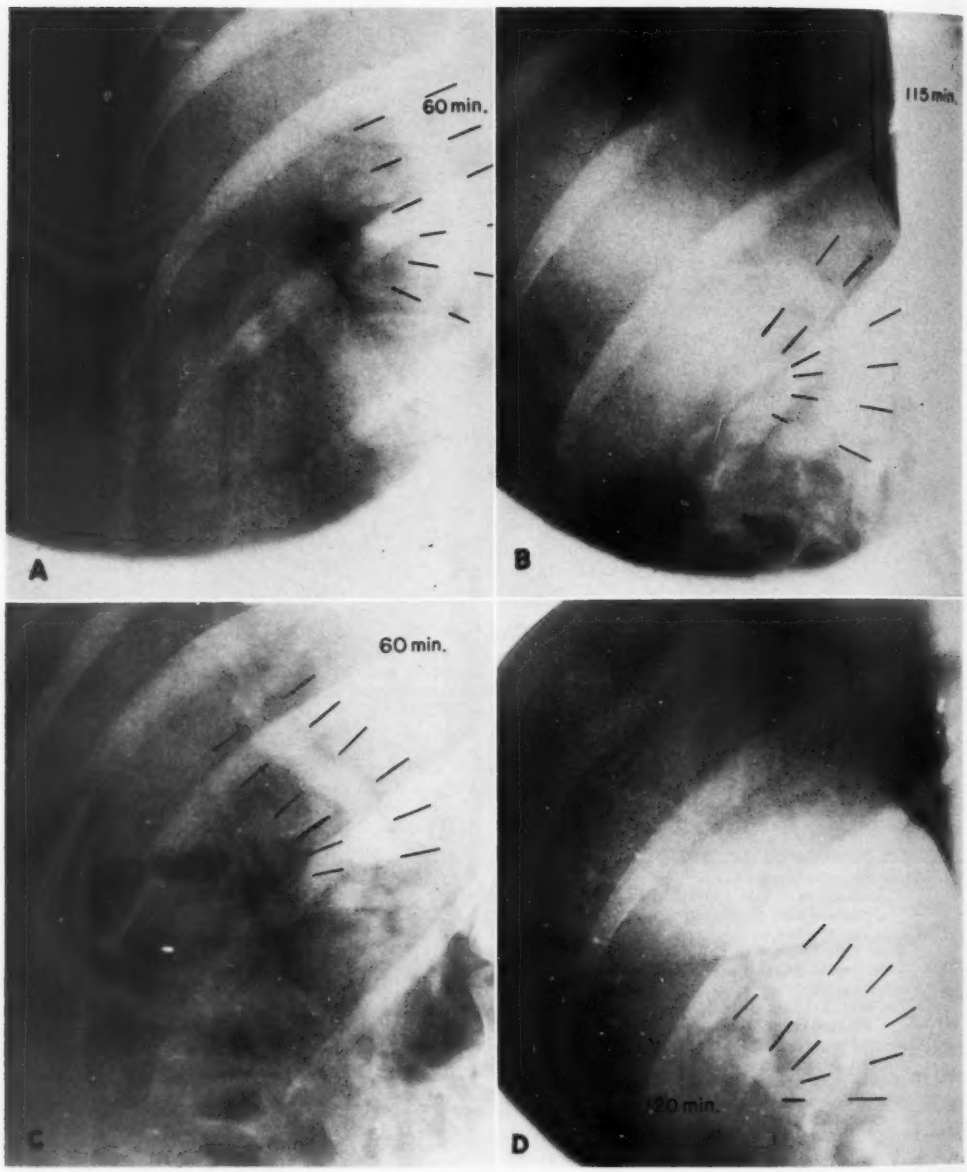

Fig. 4. A. Gallbladder is intact but not visualized with Cholografin. Presumptive evidence of cystic duct obstruction. The common duct measures 12 mm.

B. Increasing density and abnormal retention at 115 minutes, in comparison with 60-minute film (A). Exploration revealed a distended gallbladder containing multiple calculi. A fibrotic sphincter of Oddi and ampulla of Vater could not be probed. Transduodenal sphincterotomy was performed.

C and D. Intravenous cholangiography nine months after surgery showed a normally draining common duct. Note decreasing density and normal drainage at 120 minutes in comparison with the 60-minute film.

second most common cause of dilatation and calculi the third.

Common ducts which were considered normal prior to exploration of the duct and later proved to be unobstructed ranged in size from 3 to 17 mm. (Table III). Common ducts containing calculi ranged from 4 to 17 mm. In the patients with normal

common ducts, the average diameter was seen to be 6.4 mm., and in the group with common duct calculi 10.3 mm. Measurements in the normal group thus fell within the range of normal—2 to 12 mm.—established above (Group 1, Table II), with the exception of one 17-mm. common duct. One can only speculate as to the reason for this; chronic cholecystitis and cholelithiasis were found at surgery and it is possible that a calculus had previously lodged in the common duct, producing partial obstruction, followed by dilatation, then passing beyond the sphincter leaving the duct permanently dilated.

TABLE III: SURGICALLY PROVED GALLBLADDER DISEASE (21 CASES, GROUP 2)

Diameter of Common Duct (mm.)	Normal Common Duct No. Cases	Common Duct Calculi No. Cases
3	1	0
4	1	1
5	4	0
6	2	1
7	2	0
8	1	1
10	1	1
12	2	0
17	1	2

Average diameter of common duct: normal, 6.4 mm., with calculi, 10.3 mm.
Average diameter for both groups, 8.3 mm.

In the "pathologic cholecystectomy group," as shown in Table IV, the range of diameter of proved normal common ducts was from 3 to 14 mm., with an average of 6.7 mm.; in the partially obstructed group the range was from 10 to 22 mm., with an average of 14.2 mm. The term "pathologic cholecystectomy" here indicates a nonfunctioning gallbladder due to fibrosis and consequent absence of a functioning lumen or to obstruction of the cystic duct. In this condition the biliary ducts are in essentially the same mechanical and physiologic state as with surgical cholecystectomy and may be considered as such for purposes of interpretation of the intravenous cholangiogram. We regard non-visualization of the gallbladder in the presence of visualization of the bile ducts presumptive evidence of a functionless gallbladder.

In the combined groups (Tables III and IV), representing 64 cases with surgically proved gallbladder disease, the average diameter of the common ducts is seen to be 9 mm.

TABLE IV: SURGICALLY PROVED GALLBLADDER DISEASE (43 CASES, GROUP 3)

Diameter of Common Duct (mm.)	Normal Common Duct No. Cases	Obstructed Common Duct No. Cases
3	2	0
4	5	0
5	5	0
6	4	0
7	3	0
8	2	0
10	3	4
11	2	0
12	1	3
13	0	1
14	1	1
15	0	1
18	0	3
19	0	1
22	0	1

Average diameter of common duct: normal, 6.7 mm., obstructed, 14.2 mm.
Average diameter for both groups, 9.3 mm.

TABLE V: UNOBSTRUCTED, SURGICALLY PROVED NORMAL COMMON DUCTS (15 CASES, GROUP 4)

Size of Common Duct (mm.)	No. Cases
4	1
5	3
6	1
7	3
9	2
10	2
12	1
15	2

Average diameter of common duct, 8.4 mm.

A total of 512 injections were administered to the 490 patients who had previously undergone cholecystectomy. Visualization of the biliary ducts was obtained in 432 instances, in 410 patients. The common bile ducts were measurable in 397 of the patients, ranging in diameter from 3 to 30 mm., with an average of 9.1 mm. (Group 5, Table II).

Fifteen of these patients had undergone exploratory operations for various reasons (question of calculi in the cystic duct remnant, pancreatitis, malignant disease, unexplained pain, etc.), and the common ducts in these cases were considered unobstructed (Fig. 5). The diameter of the common duct in this group ranged from

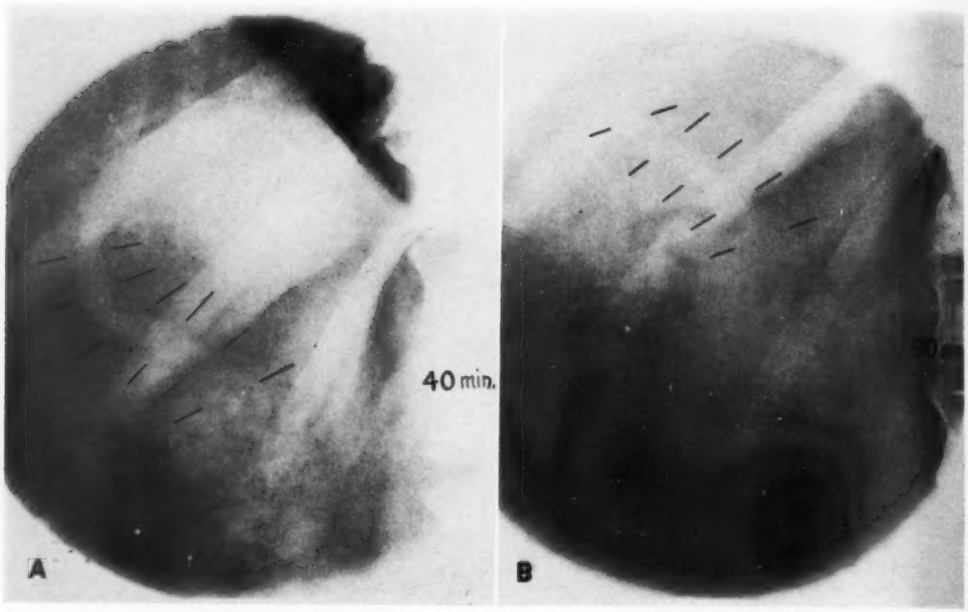

Fig. 5. A Gallbladder has been removed. At 40 minutes (A) the common duct is well visualized, measuring 10 mm. A 90 minutes (B) considerable drainage and decrease in density have taken place. The duct was considered unobstructed but at exploration, carried out because of possible pancreatitis, chronic pancreatitis was found. The common duct was unobstructed; a No. 7 Bâkes dilator passed with ease.

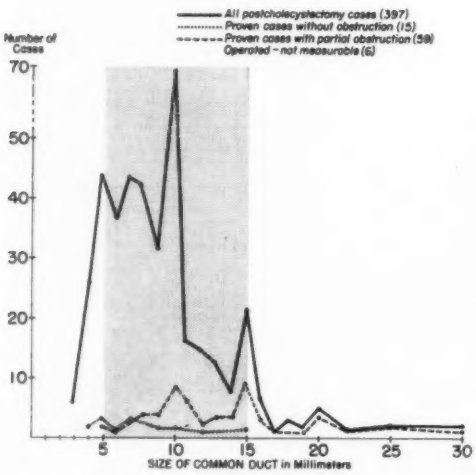

Fig. 6. Postcholecystectomy common duct size. Note the wide overlap of range of size in the unobstructed and partially obstructed groups.

4 to 15 mm. with an average of 8.4 mm., as shown in Table V. Of the entire postcholecystectomy group, 61 patients were proved to have some element of obstruction of the common bile duct, with the ducts ranging in diameter from 5 to 30 mm., the average being 13.5 mm. In a comparison of these two groups, a considerable overlap in the range of measurements may be observed; this is shown graphically in Figure 6. This experience suggests that only in the range of 3 mm. to less than 5 mm. is size alone indicative of a completely normal common duct (8 per cent of the entire postcholecystectomy group). In the range from 16 to 30 mm., size alone appears to be indicative of obstruction (6.5 per cent of the postcholecystectomy group). In only 14.5 per cent, therefore, does size as the sole criterion indicate the presence or absence of obstruction. In the remaining 85.5 per cent other criteria are necessary. This is somewhat at variance with our previously published figures (14), in which no cases of partial obstruction were found in ducts measuring less than 8 mm. Thus, it appears that the range where size alone is of no value in predicting patency or obstruction has been extended from 8 to 15

mm., the original figures, to 5 to 15 mm. in the present series. On the basis of both series, it appears that some degree of obstruction may be expected in ducts measuring more than 15 mm. in diameter.

POSTCHOLECYSTECTOMY DILATATION OF THE COMMON BILE DUCT

Since the work of Judd and Mann in 1917 (19) the concept of a compensatory postcholecystectomy dilatation of the common duct has been widely accepted, with the implication that this acts as a reservoir for bile in place of the gallbladder. Our experience does not support this view. It is true that in our series the diameter of the normal common duct averages 5.5 mm. and that the average diameter in our entire postcholecystectomy group is 9.1 mm., representing a significant size differential. If, on the other hand, one considers the group of 64 precholecystectomy patients proved at operation to have pathologic gallbladders, several interesting facts become apparent. Here the average diameter of the common duct is 9 mm. Once the gallbladder is removed, these patients represent a typical random postcholecystectomy group. Comparison of the two groups shows a difference in average size of the common duct of only 0.1 mm. The postcholecystectomy patients, with an average duct diameter of 9.1 mm., represent a selected series, since all the patients were examined for suspected common duct disease or to exclude such disease. Since a high percentage of these patients have been shown to have obstructive disease (15.8 per cent, Table VI) we believe this selection may account for the very slight increase in the average diameter of the common ducts as compared with the random group described above.

In Table VII, representing the total of 397 postcholecystectomy patients with measurable ducts, 350 patients (88.2 per cent) are seen to have common ducts well within the normal range of 2 to 14 mm. previously established (Group 1, Table II), while 75, or 18.8 per cent, actually have common ducts measuring less than the normal average of 5.6 mm. No constant relationship exists between common duct

TABLE VI: 65 POSTCHOLECYSTECTOMY OPERATIVE CASES WITH OBSTRUCTIVE DISEASE

Diagnosis	Common Duct Diameter (mm.)	No. Cases
Common duct calculi without associated stricture or fibrosis	5 to 30	17
Common duct calculi with associated stricture or fibrosis of the sphincter of Oddi	10 to 22	14
Fibrosis of sphincter of Oddi, ampulla of Vater or papilla	6 to 20	16
Malignant tumors: carcinoma of pancreas; carcinoma of ampulla of Vater	20	2
Benign polyp common duct	8	1
Benign strictures, not including sphincter of Oddi or ampulla of Vater (one case with associated fistula)	10 to 15	7
Benign strictures	Ducts immeasurable (biliary radicles dilated and blunted)	2
Stricture right hepatic duct	9	1
Common bile or common hepatic duct strictures with associated fistula	Ducts immeasurable (biliary radicles dilated and blunted)	4
Narrow intrahepatic portion common duct	10	1
Total proved obstructed cases (15.8 per cent of total group of 410 postcholecystectomy patients)		

TABLE VII: DIAMETER OF COMMON DUCT IN POSTCHOLECYSTECTOMY GROUP (397 CASES WITH MEASURABLE DUCTS)

Diameter (mm.)	No. Cases	
3	6	
4	26	
5	43	
6	37	
7	43	
8	42	350
9	31	(88.2%)
10	69	
11	16	
12	15	
13	13	
14	9	
15	21	
16	8	
17	1	
18	3	
19	2	
20	7	
22	1	
25	2	
30	2	

TABLE VIII: TIME INTERVAL AFTER CHOLECYSTECTOMY IN POSTCHOLECYSTECTOMY GROUP

Diameter of Common Duct (mm.)	No. Cases	Average Years after Cholecystectomy	Range (years)
3	4	2.5	2–4
4	18	4.8	1–17
5	34	6.5	1–26
6	32	5.9	1–24
7	34	7.8	1–20
8	31	7.8	1–28
9	27	8.3	1–24
10	54	5.3	1–32
11	9	5.6	2–19
12	13	7.4	1–23
13	14	9.0	1–19
14	8	8.5	2–20
15	21	9.0	3–18
16	5	7.4	4–10
17	1	2.0	2–
18	3	10.6	7–13
19	1	18.0	18–
20	4	12.5	1–28
25	2	9.0	4–14

size and duration of the postcholecystectomy state (Table VIII).

In only 3 patients did we have the opportunity to compare precholecystectomy and postcholecystectomy intravenous cholangiograms. In 1 case the preoperative common duct size was 12 mm. Fibrosis of the sphincter of Oddi was found at surgery, and sphincterotomy was performed. Intravenous cholangiography nine months later revealed no increase in the size of the common duct. In the second case, the common duct measured 10 mm., and sphincterotomy for fibrosis of the sphincter of Oddi was performed. Intravenous cholangiography ten months later failed to show an increase in the size of the common duct. In the third case, the common duct measured 10 mm. before operation. Calculi were found in the gallbladder, hepatic ducts, and common duct. Intravenous cholangiography one year later showed an increase in diameter to 20 mm., but 6 obstructing common duct calculi were found to account for this (Fig. 7).

Admittedly, these 3 cases are of little or no statistical significance, but in this small group there is no indication that postcholecystectomy dilatation of the common duct occurs unless obstruction is present. We consider these findings to be in conflict with the concept of postcholecystectomy dilatation of the common bile duct. If our conclusions are accepted, it follows then that in the presence of dilated postcholecystectomy ducts there must be a search for the cause. Since we have shown that a significant number of postcholecystectomy dilated ducts are free of obstruction or other pathologic change, the problem resolves into one of differentiation of obstructed and unobstructed ducts.

TABLE IX: SURGICALLY PROVED PARTIALLY OBSTRUCTED COMMON DUCTS (POSTCHOLECYSTECTOMY GROUP)

Diameter of Common Duct (mm.)	No. Cases
5	2
6	1
8	4
9	4
10	9
11	7
12	2
13	3
14	3
15	9
16	3
17	1
18	1
19	1
20	5
22	1
25	2
30	1

BILIARY DUCT OBSTRUCTION

Great emphasis has been laid upon the role of residual common duct calculi in the symptomatic patient who has undergone cholecystectomy. The search for these calculi has been the most obvious application of the intravenous cholangiogram. It is obstruction, however, partial or complete, intermittent or constant, which is the basis of the symptomatology and frequently of subsequent hepatic damage. Table VI summarizes our experience with the multiple causes of biliary duct obstruction. As shown in this table, calculi without associated pathologic changes account for only a part of the total problem of obstruction. In our previous studies (14), a definite time-density-retention relationship over a two-hour period has been indicated. This concept, restated, is based upon the curves shown in Figure 8, which

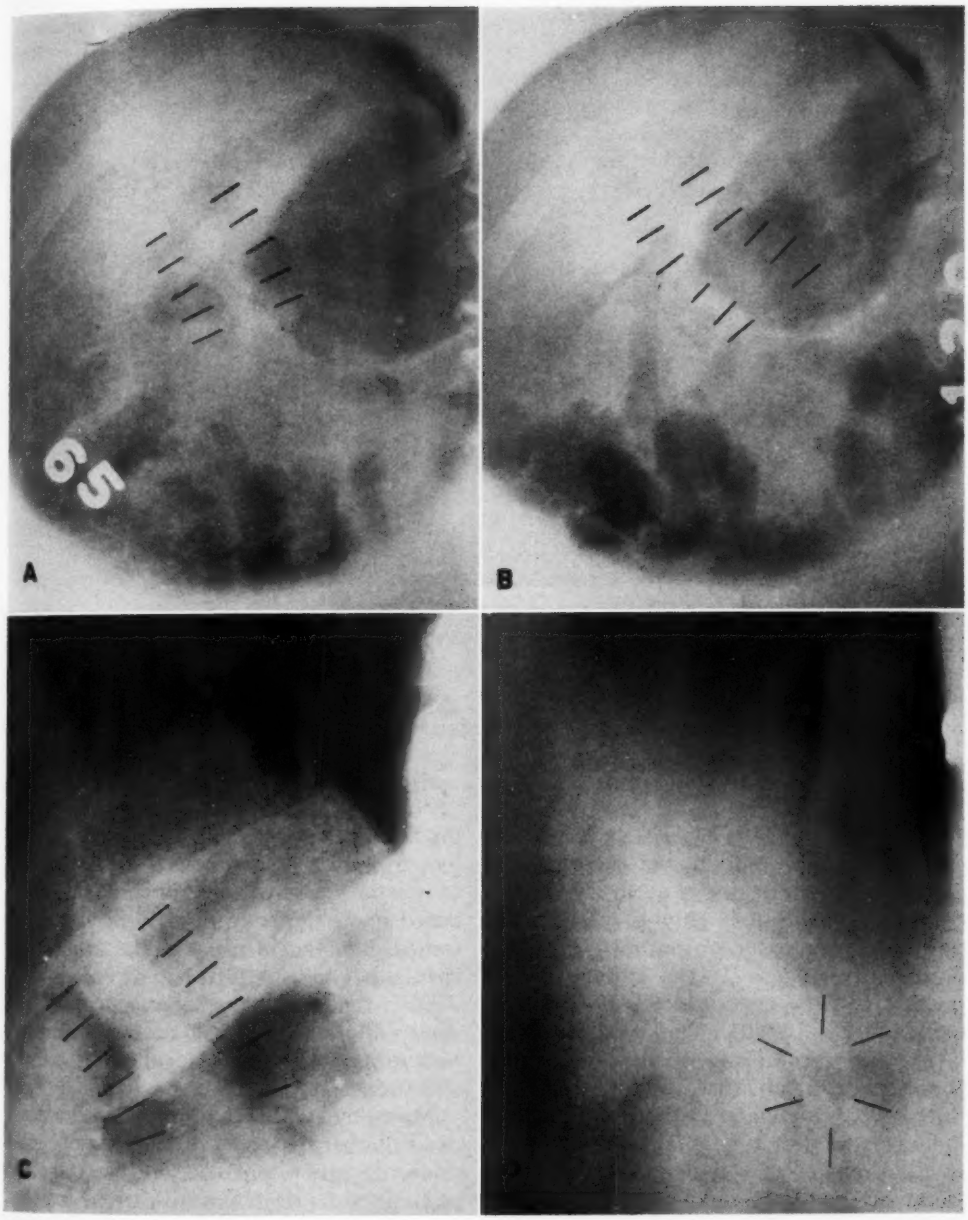

Fig. 7. Gallbladder is intact but not visualized with Cholografin. There is presumptive evidence of cystic duct obstruction. Sixty-five- and 120-minute films show abnormal retention (A and B). The common duct measures 10 mm. Exploration revealed a small fibrotic gallbladder surrounded with numerous dense adhesions. The posterior wall of the gallbladder was absent. Calculi were found in the common hepatic duct and one (1 cm.) stone was found in the common duct. A fistulous tract containing one stone was discovered between the gallbladder and common hepatic duct. The sphincter of Oddi was patent. C. Intravenous cholangiogram one year later shows marked increase in common duct size (20 mm.) as a result of 6 stones impacted in the distal common duct. D. Body-section roentgenogram showing impacted calculi responsible for common duct dilatation. The sphincter of Oddi was again found to be patent at surgery.

show that in the completely unobstructed duct there is a "fall-off" in density or retention of Cholografin-stained bile in the duct after sixty minutes. The partially obstructed ducts have been shown to maintain at one hundred and twenty minutes either the same or greater density than at sixty minutes. On this basis, we have predicted partial obstructions of the common duct with a high degree of accuracy. This concept is applicable only to cases with postcholecystectomy or pathologic cholecystectomy ducts. If the gallbladder is present and the cystic duct is patent, the gallbladder fills with Cholografin-stained bile and acts as a "safety valve" to reduce the intraductal pressure, and the common duct may thus remain visualized for an indefinite period of time. The same is true in the presence of a fistulous communication with the common duct.

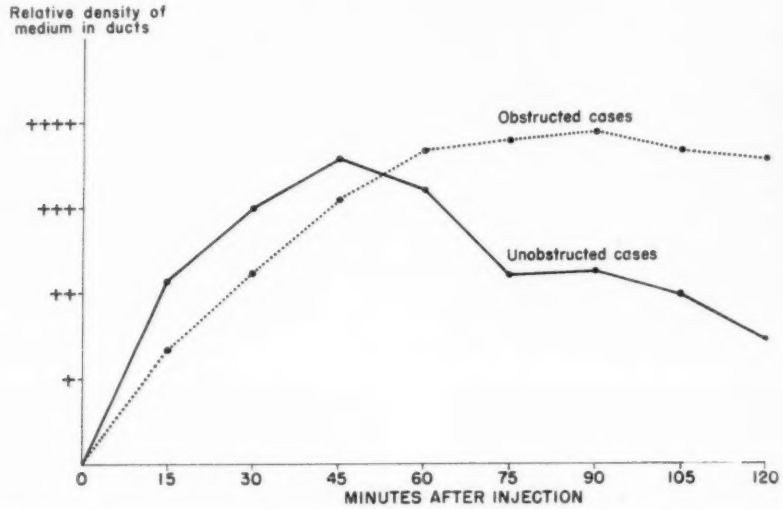

Fig. 8. Composite curves illustrating relative densities of contrast substance and drainage rates of unobstructed *versus* obstructed ducts (14).

This concept is dependent upon an apparent normal clearance rate of Cholografin from the blood stream by the liver with a constant intraductal pressure (excluding excretion by the kidneys, which theoretically should be constant in the normal patient). This has not been accurately determined, but our experience, as indicated by the curves of Figure 8, suggests that the clearance rate is less than two hours. The concept is not new to radiology; our interpretation of the intravenous pyelogram using any of the many iodinated contrast media is based on a clearance rate of forty-five to sixty minutes for the usual 20 to 30 c.c. of solution injected. By the same token, the diagnosis of partial obstructions of the ureter is based upon the concept of abnormally retained dye-stained urine in the ureter and kidney beyond forty-five to sixty minutes. This is true even in the presence of only slight dilatation of the ureter, produced perhaps by a small calculus or partial stricture.

Morphology also contributes to the diagnosis of obstruction. It has been noted in minor degrees of obstruction that the common duct tends to lose its usual tapered shape and assumes a more tubular configuration. In more severe degrees of obstruction the biliary radicles also appear slightly distended. In markedly severe obstruction there are observed, in addition to gross dilatation of the common duct, a tortuosity and blunting of the biliary radicles not unlike that seen in hydronephrosis.

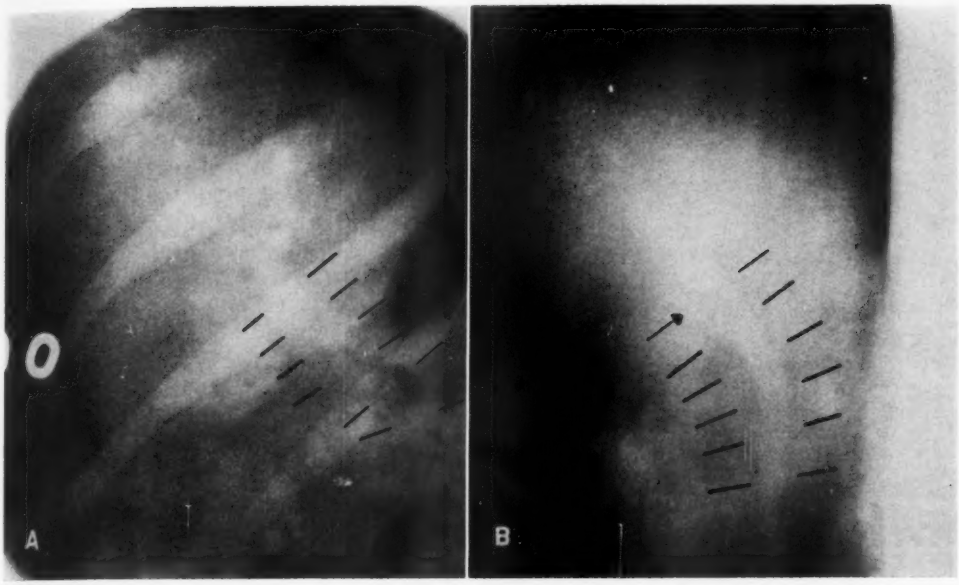

Fig. 9. A. Normal postcholecystectomy common duct obscured by gas shadows. B. Body-section roentgenogram yields good visualization without evidence of calculi. Note cystic duct stump.

To this latter condition the term "hydrohepatosis" was applied by McMaster *et al.* (20) in 1923. Counseller and McIndoe (21), in 1926, demonstrated this condition in the liver by the production of casts of autopsy specimens, using a solution of celluloid in acetone.

COMMON DUCT CALCULI

Although intravenous cholangiography has been of great help in the diagnosis of intraductal calculi, many difficulties have arisen. At best, visualization of the ducts is relatively poor in comparison with the dense shadows obtainable today with intravenous pyelography, and this inherent deficiency contributes to the difficulty of visualizing calculi. This, coupled with the difficulty of completely clearing the right upper quadrant of gas shadows, necessitates strict control of radiographic technic and positioning of the patient. Body-section radiography lends itself to visualization of the common duct, since fortunately, in the supine position, this structure lies parallel to the table top. The technic (22) has been very helpful in diagnosis from the standpoint both of exclusion and of confirmation of calculi (Fig. 9). Unless the calculus is at least partially surrounded by Cholografin-stained bile, however, it cannot be detected by either conventional or body-section technics. A significant number of calculi are impacted in the ampulla and cannot be visualized. It is in these instances that the examiner must be cognizant of the drainage factor if large numbers of calculi are not to be overlooked (Fig. 10). In our postcholecystectomy series we obtained surgical proof of common duct calculi in a total of 31 patients. In 17 of these there was no other element of obstruction. The calculi were actually visualized in 10 cases. In 6 the diagnosis was made on the basis of abnormal drainage or retention of Cholografin-stained bile in the common duct, utilizing the time-density-retention relationship, and in 1 the calculus was not diagnosed prior to operation. In the group of 14 patients with proved common duct calculi associated with secondary obstruction, such as stricture or fibrosis of the sphincter of Oddi, the calculi were actually

Fig. 10. Postcholecystectomy 30-minute film. Markedly dilated (30 mm.) common duct showing marked retention at 120 minutes. No calculi are visualized. On basis of size and abnormal retention, the duct was considered obstructed. Exploration revealed several large obstructing calculi. The sphincter was not fibrosed. A No. 6 Bâkes dilator passed easily.

visualized in 8 instances and diagnosed on the basis of abnormal retention in 6. Thus, in the entire group of 31 cases of calculi, the diagnosis was made by actual visualization in 18 instances and on the basis of abnormal retention in 12, with 1 case remaining undiagnosed.

FIBROSIS OF THE SPHINCTER OF ODDI AND AMPULLA OF VATER

In the operated group of postcholecystectomy cases, 16 patients were proved at surgery to have stenosis of the lower end of the common duct due to fibrosis of the sphincter of Oddi, ampulla of Vater, or major papilla. There were no associated common duct calculi. The ducts ranged in diameter from 6 (fibrosis of papilla) to 20 mm. In 2 cases, no preoperative diagnosis was made. In the remainder, the diagnosis was predicted on the basis of abnormal retention (Fig. 11). In 11 cases there were associated calculi in the common duct, the latter structure ranging in size from 10 to 22 mm. In all of these, obstruction was predicted preoperatively. In the operated group of precholecystectomy patients, stenosis was found in 8 cases, the common duct size varying from 10 to 18 mm. In 1 of these cases the obstruction was not predicted, but cholecystojejunostomy had been performed previously. This acted as an escape valve, nullifying the retention concept. Thus, in a total of 35 cases, partial obstruction of the common duct was correctly predicted in 32 instances.

In 3 of 15 postcholecystectomy common ducts which were considered unobstructed at operation, obstruction had been predicted, and in 3 precholecystectomy common ducts obstruction had been predicted and the ducts were found to be normal at operation. In retrospect, these ducts showed borderline retention on the films and in no instance was there evidence of increasing density beyond one hundred and twenty minutes.

The concept of fibrosis of the sphincter of Oddi and ampulla of Vater appears to be gaining wider acceptance, as shown by Cattell and Warren (23) in a recent review of the subject. Cattell, Colcock, and Pollack analyzed their experiences at the Lahey Clinic in two groups (7, 8). In the first group, composed of 49 patients, they reported follow-up studies of six months or more in 37; complete relief of symptoms was obtained in 28, improvement in 6, and no relief in 1; 2 of the patients died. In the second group, comprising 102 patients, they achieved excellent relief of symptoms in 82, improvement in 9, and poor results in 11. These findings, we believe, emphasize the importance of the concept and the need for accurate preoperative roentgen diagnosis if intravenous cholangiography is to be utilized to its greatest potentiality. In their second report, these authors stated that liver function studies were helpful in only about one-third to one-half of the cases and, further, that reliance was placed chiefly upon the intravenous cholangiogram in preoperative diagnosis. In this same series the obstruction was

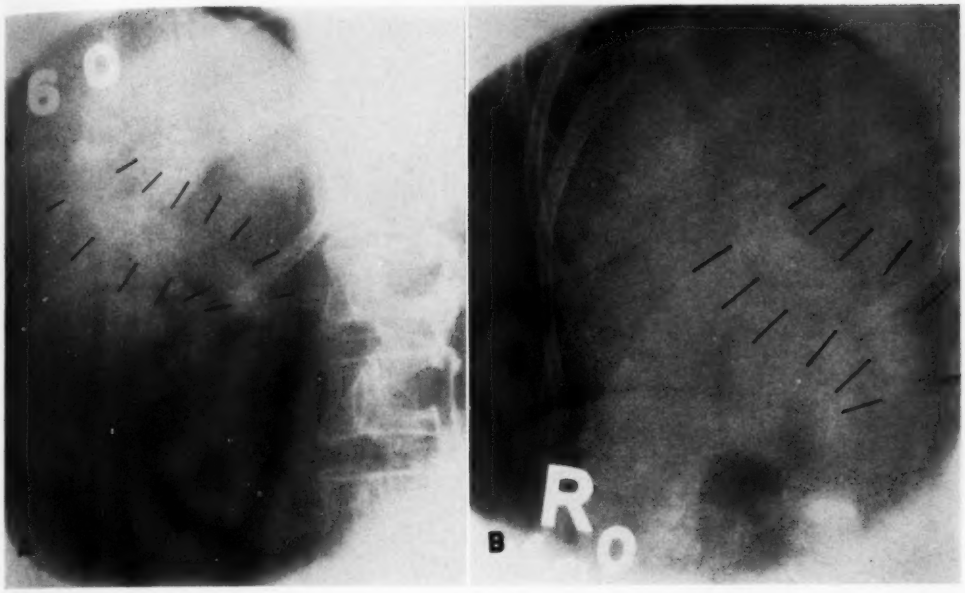

Fig. 11. Postcholecystectomy films. The common duct was found to be dilated to 20 mm. A and B show abnormal retention indicative of partial obstruction of the distal end of the duct. Surgical exploration revealed a marked fibrosis of the sphincter of Oddi and sphincterotomy was performed.

predicted correctly in 33 of 36 cases on the basis of the time-density-retention concept.

In stenosis of the lower end of the common bile duct, the time-density-retention concept appears to be valid and reliable in detecting partial obstructions.

BILIARY DUCT STRICTURES

The vast majority of patients with strictures of the common bile duct seen at this Clinic were not examined by intravenous cholangiography, since the marked hepatic damage and frequent jaundice preclude any possibility of visualization of the ducts. In 7 patients with strictures, however, good visualization of the ducts was obtained, with a range in diameter from 10 to 15 mm., all showing abnormal retention of the medium (Fig. 12). In addition, marked narrowing of the intrapancreatic portion of the common duct was evident in 1 case, and stricture of the right hepatic duct in another. In 4 of these cases, visualization was obtained both proximal and distal to the stricture. Radiographically, the ducts were characterized by a marked differential in size, with a very abrupt transition above and below the stricture. There was visible evidence of the medium in the duodenum. This is not surprising, since these are not complete strictures and the patients did not present a significant degree of jaundice, although they did show abnormal retention of the medium. The diagnosis of partial stricture thus depends upon morphology, in the sense of marked differential in size above and below the level of narrowing, abrupt transition in size, and abnormal retention.

In an additional 2 cases the biliary radicles appeared blunted, dilated, and tortuous, and on this basis obstruction, probably due to stricture, was predicted and subsequently found at operation. In the remaining 4 cases in which fistulas associated with stricture were encountered at surgery, a definite obstruction could not be predicted but abnormalities in the form of rapid appearance of medium in the intestinal tract without visualization of the common duct, blunted radicles, or an un-

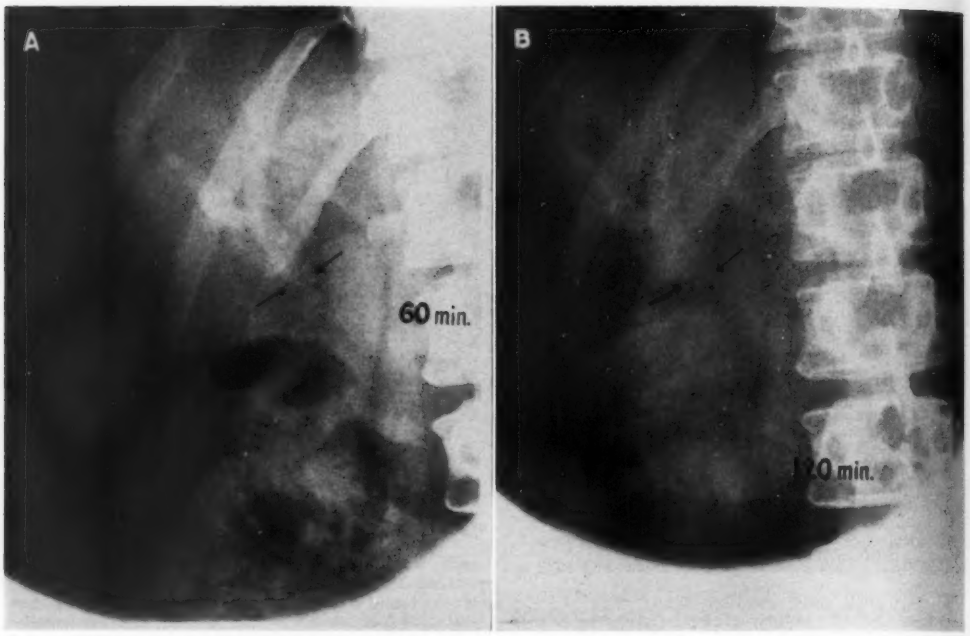

Fig. 12. Postcholecystectomy films. Common hepatic duct measures 15 mm. Common bile duct, very faintly seen, is approximately half as large, with abrupt transition between the two segments. Note distended biliary radicles.

A. and B. Abnormal retention. Surgical exploration revealed a stricture of the common duct with thickening of the walls and distention of common hepatic duct portion. Distally, the duct was not significantly dilated and the walls were of normal thickness.

usually shortened, poorly visualized, tortuous common duct, were noted.

TUMORS

A single benign tumor was diagnosed and proved. In this instance, abnormal retention of the contrast substance in a 10-mm. common duct was observed, and a diagnosis of partial obstruction of the distal common duct was made. A small polyp of the distal common duct was discovered at surgery.

In 2 postcholecystectomy patients, abnormal retention was noted in 20-mm. common ducts (Fig. 13). At surgery, inoperable carcinoma of the pancreas was found in one; in the other the partial obstruction was due to carcinoma arising in the ampulla of Vater. In the precholecystectomy group, 4 carcinomas responsible for partial obstruction of the common bile duct were found. The ducts ranged in diameter from 12 to 18 mm. In all 4 instances a preoperative diagnosis of partial obstruction was made; at operation, carcinoma of the head of the pancreas was found in 1, carcinoma of the ampulla of Vater in 2, and malignant carcinoid of the ampulla of Vater in 1. Thus, a diagnosis of partial obstruction of the common duct was made in 6 patients with malignant tumors and in 1 with a benign polyp.

NON-VISUALIZATION OF THE GALLBLADDER

We have considered non-visualization of the gallbladder in the presence of visualization of the ducts to be presumptive evidence of cystic duct obstruction due to calculi, infection, fibrosis, etc. In this group, 46 patients were operated upon, and the gallbladder was found to be essentially normal in 6. Sclerosing cholangitis was found in 1 case, and in 1 the gallbladder was moderately distended (patient having previously had jaundice); in 4 cases car-

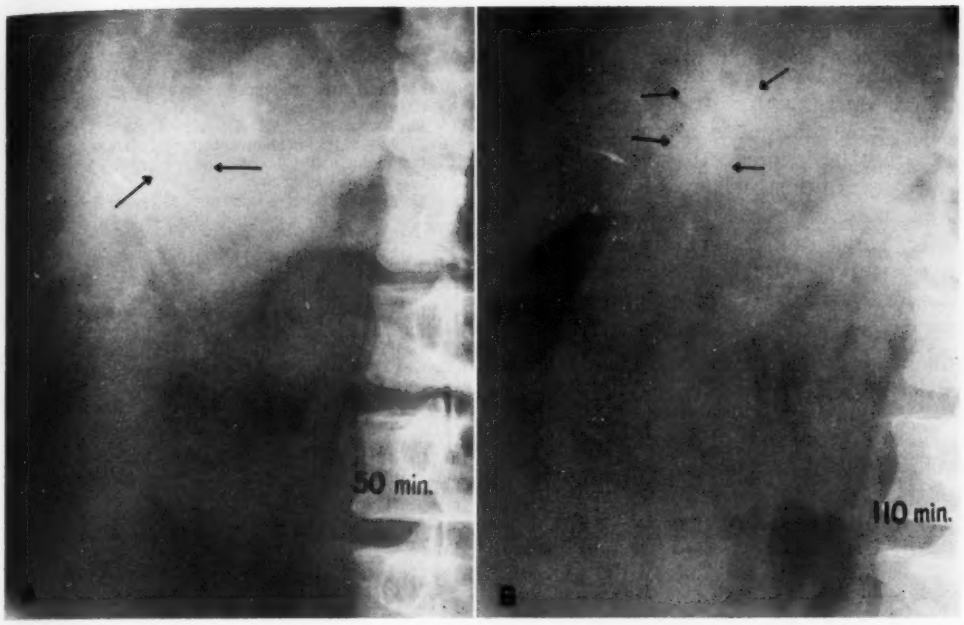

Fig. 13. Postcholecystectomy films. A. Common duct is markedly shortened and dilated to 20 mm. B. Note dilated and blunted biliary radicles and abnormal retention at 110 minutes. Surgical exploration revealed inoperable carcinoma of the head of the pancreas.

cinomas of or about the distal common duct were found, and in 2 cases the gallbladders were not visualized apparently because of fistulous communications between the gallbladder and the intestinal tract. It would appear, therefore, that non-visualization of the gallbladder in the presence of visualization of the common duct must remain presumptive although highly probable evidence of gallbladder disease.

In 1 instance, the gallbladder failed to visualize in the usual two-hour period but was well demonstrated on a film of the abdomen twenty-four hours later. For this reason, we now obtain a twenty-four-hour film of the gallbladder area when the gallbladder fails to visualize but visualization of the ducts is obtained.

CONCLUSIONS

Intravenous cholangiography is a relatively safe procedure. Although we do not believe it should be substituted for routine oral cholecystography, we consider its use warranted in all cases of non-visualization of the gallbladder with the oral method, in order to evaluate with greater accuracy both the gallbladder and the bile ducts preoperatively. In cases with oral visualization and visualized gallbladder calculi, preoperative intravenous cholangiography also yields considerably more information with respect to the status of the biliary ducts.

There is no evidence in this series to support the concept of postcholecystectomy compensatory dilatation of the common bile duct.

Size is of considerable importance in estimating patency or obstruction of the common duct when it is either extremely small or extremely large. In 85.5 per cent of postcholecystectomy patients the time-density-retention concept appears to have a valid basis in the diagnosis of partial obstruction of the biliary duct produced by any of the various causes.

Early diagnosis of malignant changes of or in the region of the common bile duct

may be made in some instances before the usual radiographic signs become evident.

Precholecystectomy evaluation of the biliary ducts with intravenous cholangiography should materially contribute to lowering the incidence of postcholecystectomy symptomatology, since many of these complaints are due to incomplete biliary duct surgery, and more accurate preoperative evaluation of the bile ducts should lead to more exact and definitive surgery.

Diagnosis of the many organic causes of postcholecystectomy symptomatology can lead to a higher rate of relief through surgery. Exclusion of these same factors will permit the internist to search elsewhere for the cause of the symptoms, with the assurance that the biliary tract is not responsible.

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SUMMARIO IN INTERLINGUA

Le Diagnose per Cholangiographia Intravenose de Obstruction Partial del Ducto Commun

Le autores reporta lor experientias con cholangiographia intravenose in un serie de 770 injectiones administrate a 746 patientes. Lor conclusiones es le sequente: Ben que cholangiographia intravenose non deberea esser substituite pro routinari cholecytographia oral, illo es un relativemente salve manovra. Su uso es justificate in omne casos in que medios oral non effectua visualisation del vesica biliari, pro evalutar le vesica biliari e le ductos de bile plus accuratemente ante le operation. In casos in que le vesica biliari es visualisate per medios oral sed in que iste medios resulta in le demonstration de calculos, preoperative cholangiographia intravenose produce considerabilemente plus information in re le stato del ductos biliari.

In iste studio, nulle observationes esseva facite in supporto del conception de un dilatation del commun ducto biliari occurrente post cholecystectomia.

Le factor del magnitude es de importantia considerabile in estimar patentia o obstruction in le ducto commun quando isto es extrememente parve o extrememente grande. In 85,5 pro cento del patientes postcholecystectomic, le concepto del tempore del retention de densitate jocava apparentemente un rolo valide in le diagnose de obstruction partial del ducto biliari.

In certe casos le diagnose de processos maligne in le region del commun ducto biliari o in le commun ducto biliari mesme pote esser effectuate ante que le usual signos radiographic deveni evidente.

Le evalutation precholecystectomic per medio de cholangiographia intravenose deberea contribuer a un reduction considerabile de symptomas postcholecystectomic, proque multe tal gravamines es le resultato de incomplete chirurgia del ducto biliari, e un plus accurate evalutation preoperatori del ductos biliari deberea resultar in plus exacte e plus definitive procedimentos chirurgic.

Le diagnose del grande numero de causas responsabile pro le symptomatologia postcholecystectomic pote resultar in un plus alte procentage de alleviamento effectuate chirurgicamente, e le demonstration del absentia de tal causas permitte al internista cercar alterubi le factores responsabile pro le symptomas, con le certitude que le vias biliari non es a blasmar.

Congenital Goiter[1]

W. WILLIAM NAGLE, M.D.,[2] JOHN W. HOPE, M.D., and ALFRED M. BONGIOVANNI, M.D.

CONGENITAL goiter has never been of common occurrence in the United States and at the present time may be considered a rarity. Prior to the widespread prophylactic use of iodine, the condition was encountered fairly often in the goiter belts of Europe. Fodéré in 1796 first described the entity; by the early twentieth century, several hundred cases had been recorded. In this country, Skinner, in the state of Washington, published the largest number of cases, reporting 15 of his own (1, 20). Jones (2), in his review of the subject, collected 47 cases from the North American literature.

It has been our privilege to see 3 cases of congenital goiter within the past three years. Because of the general unfamiliarity with the entity in our institution when the first case was observed, and in view of the absence of reports on this subject in the radiological literature in the English language, we believe that a review of the disease is justified. Our study consists of a presentation of our own cases, with a compilation of material published in English since 1900.

CASE REPORTS

CASE I: K. N., a white female infant, was admitted at the age of nineteen days with a history of a swelling in the neck since birth and choking spells associated with feeding during the previous five days. There had been a weight loss of 18 ounces since birth. The mother, a thirty-eight-year-old nurse, had had two previous pregnancies. During the fifth month of her last pregnancy, her basal metabolism rate exceeded + 50 per cent, and she was given Lugol's solution (10 drops daily), propylthiouracil (300 mg. daily), and digitalis. The propylthiouracil was discontinued after two months and the digitalis after one month; Lugol's solution was given throughout the pregnancy.

On admission, the infant's pulse rate was 250 and the blood pressure 80/40. A collar-like mass in the neck extended laterally to the angles of the mandible, and the neck veins were distended. The serum cholesterol was 85 mg. per cent and the protein-bound iodine 18.7 micrograms per cent. Roentgen examination revealed a large soft-tissue mass in the retropharyngeal space, producing a kyphosis of the cervical spine (Fig. 1). The patient was placed in oxygen and received propylthiouracil (5 mg. every six hours) and Lugol's solution (5 drops every six hours) for one week only, with gradual improvement. She was discharged in good condition. A repeat roentgen examination five weeks after admission showed the soft-tissue mass to be much smaller and the cervical spine to be straight (Fig. 2). At two and a half years of age the child was normal, with no evidence of thyroid disease.

CASE II: B. R., a white female infant, was admitted immediately after birth because of a swelling in the neck, dyspnea, and cyanosis. The mother was twenty-six-years old, and since the second month of pregnancy had received 5 grains of potassium iodide three times daily because of a basal metabolism rate of +32 per cent.

A large, smooth goiter was present in the child's neck, extending laterally beyond the sternocleidomastoid (Fig. 3). There was slight cyanosis. The blood pressure was 90/60, and the pulse rate 140. The serum cholesterol was 144 mg. per cent and the protein-bound iodine "too high to read." On the fourteenth day of life it was 17.5 micrograms per cent and on the twenty-eighth day 14.8 micrograms per cent. Roentgenograms revealed a soft-tissue mass surrounding the trachea, with posterior displacement of the esophagus (Fig. 4). The infant was placed in oxygen and the goiter diminished in size without further treatment. Within two weeks respiration and swallowing were normal. Repeat roentgen examination at this time showed a reduction in the soft-tissue mass (Fig. 5). At two years of age the child was entirely normal in all respects.

CASE III: N. N., a white female infant, was admitted at the age of twelve hours with a symmetrical, collar-like mass in the neck, cyanosis, and dyspnea. Careful questioning indicated that the mother had not received any known goitrogenic foods or drugs, nor had she suffered from thyroid disease. Examination of the child revealed suprasternal and sub-

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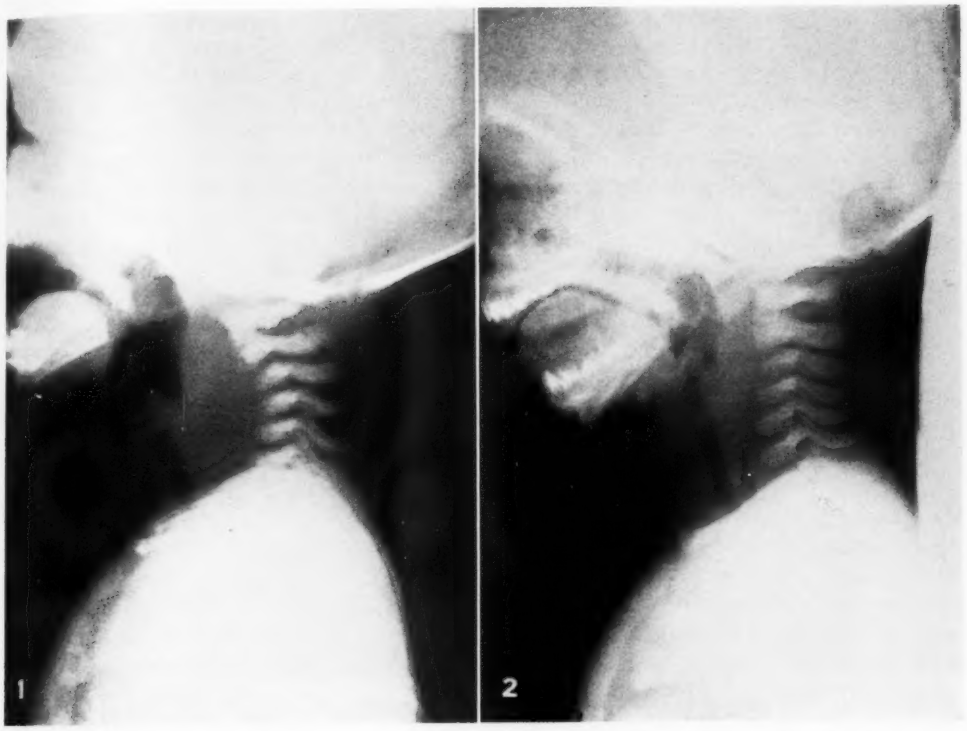

Fig. 1. Congenital goiter in a nineteen-day-old female (Case I). The retropharyngeal growth is genuine, and is not to be confused with the "false mass" caused by buckling of the infant trachea during expiration. Reversal of the curvature of the cervical spine from a normal lordotic curve to a true kyphosis is evident. This kyphotic curve was apparent in a number of films, taken with various technics.

Fig. 2. Roentgenogram of the same infant seen in Figure 1, taken after five weeks. The retropharyngeal mass is seen to be smaller and the cervical spine is straight.

sternal retraction. Bronchoscopy showed marked compression of the trachea, both anteriorly and laterally.

A thyroidectomy was performed on the first day of life, and about 80 per cent of the gland (13 gm.) was removed. The first protein-bound iodine determination, on the third day of life, was 6.3 micrograms per cent. On the tenth day, the serum calcium was 6.3 mg. per cent and there were clinical signs of tetany. Calcium chloride and Drisdol were given for two months, after which the calcium returned to normal and there were no further clinical signs of tetany. Examination of the removed thyroid tissue showed "large, very irregular, convoluted acini, some of which contained a small amount of colloid. The lining cells varied greatly in size and shape. The nuclei were pleomorphic, hyperchromatic, and at times of bizarre appearance.

Fig. 3. Congenital goiter in a newborn female (Case II). The large smooth goiter is clearly seen, extending to the left sternocleidomastoid. Note also the extension of the infant's head and neck in an effort to obtain a better airway.

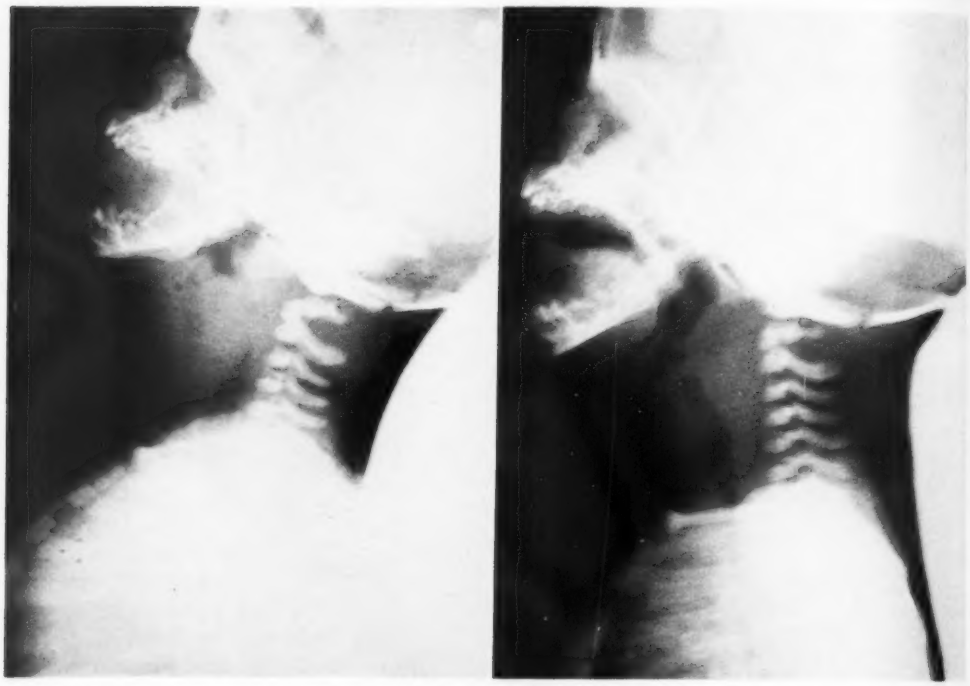

Fig. 4 (left). Roentgenogram of the patient photographed in Figure 3. The enlarged thyroid is visualized both in front of and behind the trachea. Air in the esophagus permits visualization of the posterior displacement of this structure by the retrotracheal extension of the thyroid mass.

Fig. 5 (right). Repeat roentgenogram taken two weeks after admission. The thyroid mass is now much smaller, although a portion of it remains in the retropharyngeal space.

Diagnosis: Hyperplastic variant of congenital goiter."

At one month, marked mottling of the skin developed, with puffiness of the face, enlargement of the tongue, and constipation. The protein-bound iodine had fallen to 1.9 micrograms per cent and it subsequently was necessary to maintain the child on desiccated thyroid. Eighteen months later, the patient was normal in all other respects. No roentgen studies were performed in this case.

CLINICAL AND ROENTGENOLOGIC CONSIDERATIONS

In cases of congenital goiter, the patient is born with a mass in the thyroid region. This is usually soft and symmetrical, although some asymmetrical goiters have also been described. Symptoms vary, depending on the size and location of the mass. Respiratory distress with cyanosis is common and at times severe. Crying or feeding may aggravate the difficulty. The infant's head and neck are frequently extended in an effort to obtain a better airway (Case II, Fig. 3), and there may be a low, hoarse cry.

X-ray examination generally shows an evenly outlined soft-tissue mass in the thyroid region that surrounds the trachea, and sometimes the esophagus, compressing and displacing these structures (3–7). In our Case I (Fig. 1), the normal curvature of the cervical spine appeared to be reversed by the pressure of the mass. Care must be taken that interpretation is made only of films taken in full inspiration, since the normal infant trachea buckles forward during expiration, giving the impression of a retrotracheal soft-tissue swelling.

The vast majority of infants born with thyroid enlargement show no evidence of thyroid hormone abnormality. While several authors have mentioned the possibility of hyperthyroidism, Koerner, in his study of the disease in children under

the age of one year, found only one case, in addition to his own, in which hyperthyroidism was apparently present at birth (8, 9). It should be noted that the usual laboratory tests may be misleading. During pregnancy the maternal butanol-extractable and serum-precipitable iodine normally rise to levels which are considered indicative of hyperthyroidism in a non-pregnant woman. At birth, the infant's blood contains about the same amount as that of the mother (10, 11). During the first week of life, the level rises even higher and then falls gradually during the first year. Similar elevation has been noted in I^{131} tracer studies performed on normal newborn children (12). The blood cholesterol tends to be low at birth, but rapidly becomes more normal in the post-natal period (13). For these reasons, it is obviously necessary to rely heavily on clinical impressions.

Several instances of apparent hypothyroidism associated with congenital goiter have been reported (14, 15). While the condition is generally transient, in some cases more prolonged therapy is required (16).

ETIOLOGY

Most infants with congenital goiter have been born to mothers with evidence of thyroid disease. In keeping with this observation, many congenital goiters have occurred in the classical goiter belts, presumably the result of inadequate iodine content in the maternal diet. Under these circumstances, the provision of sufficient iodine is undoubtedly an excellent preventive measure, as several authors have attested (1, 4, 17).

A brief study of the published material, however, indicates that other factors also contribute to this condition. The incidence, for example, varies considerably in different goiter areas. Skinner, in Washington, was able to collect his 15 cases over a period of several years. On the other hand, in the Great Lakes area, it appears that the disease is extremely rare (4). In this connection, Taylor found that under certain circumstances calcium had a goitrogenic action in rats, and he notes instances where the calcium content of the water supply in low-iodine areas may be related to goiter formation in man (18). In the majority of cases reported, siblings were found to be entirely normal. Investigation discloses no gross change in the mother's condition or habits during pregnancy, but suggests rather the possibility of a seasonal change in diet, resulting in a higher intake of goitrogenic substances. Davies, in reporting a family in which only males were involved, postulated a hereditary factor (7). Warren and Shpiner cite an unusual instance in which only 1 of identical stillborn twins had an enlarged thyroid (19).

Recently, the treatment of hyperthyroidism in pregnancy with thiouracil and related compounds has been the subject of considerable discussion. Elphinstone reported 10 instances of goiter which could be attributed to the use of these drugs (14). It appears that, with proper regulation of dosage, no goiter will be produced in the fetus (21, 22). Proper consideration must be given, however, to the normally elevated basal metabolism and protein-bound iodine in pregnancy (10, 14, 22). Among the other better known thyroid substances in common use are para-aminosalicylic acid, resorcinol, sulfonamides, cobalt, cyanides, and thiocyanates. Any of these might play a goitrogenic role in an individual case. In addition, iodine is deserving of special mention as a goitrogen. Paradoxically, large amounts of iodine have been shown by Bell (23), Morgans and Trotter (24), and at an Endocrine Conference in 1953 (25), to cause goiter and myxedema. Twelve years prior to these reports, Parmelee and his colleagues described 3 cases of congenital goiter in infants born to women taking large amounts of potassium iodide (17), in 2 cases for asthma and in 1 for tachycardia. Apparently the mothers suffered no ill effects, although in 1 a small goiter developed about eight months post-partum. Recently, there have appeared

several other reports of goiter in infants born to mothers who had been receiving iodine treatment (26).

The exact mechanism by which the iodine acts in these cases is unknown. Most instances have occurred in asthmatics, but the significance of this is not understood. The mode of action does not seem to be related to the ways in which iodine controls hyperthyroidism (23, 25). A theory that iodide competes with tyrosine for elemental iodine in the thyroid gland, forming a tri-iodide ion, has been advanced (27). Since not everyone who ingests large amounts of iodine has a goiter, other, unknown factors must be involved.

PATHOLOGY

Jones was able to find 13 examples of congenital goiter, including 2 of his own, in which pathologic examination was done (2). Eight of these were from autopsy material and 5 from surgical procedures performed to relieve obstruction of the airway. With the addition of several recent reports as well as 1 of our own cases (Case III), we have been able to assemble 25 pathological studies from a total of 70 cases (1–9, 14–17, 19, 20, 22, 26, 28–46). In 21 of these, the goiter was described as hyperplastic, occasionally showing involutional changes. Two cases were thought to represent Hürthle-cell adenomata (6, 31), although Jones believes that they were probably variants of the usual parenchymatous goiter. Another was labeled adenoma with colloid degeneration (33), while the last was called a malignant tumor of mesoblastic origin (37).

It is of interest that the only one of Bell's cases of adult goiter following excessive iodine ingestion, which came to pathologic examination, showed a resting goiter with much colloid (22). This is in contrast to the hyperplasia noted in the 1 case of congenital goiter produced by similar circumstances (26).

TREATMENT

The maintenance of an adequate airway is of the utmost importance in the management of the infant with a congenital goiter. The enlarged thyroid may exert compression on the trachea, and this may be most marked posteriorly. If there are significant dyspnea, stridor, retraction, and cyanosis, surgical intervention may be necessary in order to prevent death from asphyxia. Tracheotomy alone may not be satisfactory, since this may fail to relieve the retrotracheal obstruction. Under these circumstances, subtotal thyroidectomy may be advisable. If there is no significant respiratory difficulty, surgical correction is not indicated and the enlargement will usually diminish within a few weeks.

On rare occasions, thyrotoxicosis may also be present, manifested by tachycardia, diarrhea, failure to gain weight, exophthalmos, and the elevation of protein-bound iodine in the serum. It is not always easy to distinguish certain of these features from the manifestations of anoxia and, if the mother has received iodides, interpretation of an extreme elevation of the serum protein-bound iodine in the infant may be difficult. Parenteral fluids and paregoric may be employed. Specific therapy for the thyrotoxicosis should consist of the administration of iodides either by mouth or parenterally. It is probably wise to avoid the use of thiouracil drugs, since in many instances these have already been administered to the mother and may have been responsible for the production of the goiter in the child. In that event, their use may lead to further enlargement of the gland or may delay regression in size. Moreover, the iodides are more rapidly effective.

The occurrence of hypothyroidism in the newborn infant with a goiter is also uncommon; when present, it calls for appropriate substitution therapy. The possibility of "goitrous cretinism" must be considered, although enlargement of the gland at birth is not usual in that particular disease.

The prevention of goiter in the newborn requires a consideration of certain prin-

ciples in the treatment of the thyrotoxic mother. Since, during pregnancy, both the level of the protein-bound iodine in the serum and the basal metabolism rate are relatively high, the treatment of the pregnant woman with hyperthyroidism should not be directed toward the attainment of a rate of thyroid function characteristic of the non-pregnant euthyroid woman. Dosage of the thiouracil drugs should be such as to maintain a level of serum protein-bound iodine which is consistent with normal pregnancy. If the condition has been well controlled, these drugs may be discontinued within two weeks of delivery, provided this does not lead to a significant clinical remission of the maternal disease. The use of iodides, either alone or in conjunction with thiouracil derivatives, is not advantageous, since the iodides might themselves produce goiter in the newborn when administered to the pregnant female. In addition, ideal control of hyperthyroidism is not usually achieved by this means.

In view of the widespread use of goitrogenic drugs during pregnancy, an increase in the incidence of neonatal goiter may be anticipated. It is remarkable that, with the use of such compounds, including the thiouracil drugs themselves, the frequency of goiter in the newborn is not greater. It is probable that other factors, as yet not well understood, account for the occurrence of neonatal goiter.

DISCUSSION

From the foregoing observations it is obvious that, to date, the exact mechanism leading to the development of congenital goiter is unknown. Our 3 cases certainly fit into this uncertain picture. Our first 2 patients were born to mothers thought to be hyperthyroid, but this is open to question, since the usual laboratory tests are misleading during pregnancy. In Case III, the mother was normal. In Case I, the mother had received both Lugol's solution and propylthiouracil, while in Case II only potassium iodide had been administered. The mother of the third patient had received no goitrogenic medication. No common denominator exists, therefore, in the 3 cases presented.

Our addition of these cases of congenital goiter to these previously recorded is not motivated by any claim to comprehension of the problem. Our purpose is rather to introduce the subject into the radiological literature in the English language and to acquaint radiologists with the condition. Increased knowledge will undoubtedly lead to improved handling of individual cases as they appear.

SUMMARY

Three cases of congenital goiter are presented, with a discussion of the roentgen and clinical findings, pathology, etiology, and treatment. A review of the literature is included; it is believed that the present report is the first to appear in the English-language radiologic literature.

The patient with congenital goiter is born with a mass in the thyroid region, which usually is soft and symmetrical. Roentgen examination generally shows an evenly outlined soft-tissue mass in the thyroid area that surrounds the trachea and may compress and displace the esophagus.

Maternal thyroid disease and the ingestion by the mother of goitrogenic drugs, the goitrogenic action of calcium in low iodine areas, and the geographic "goiter belts" are considered in relation to etiology. It is concluded that the exact mechanism responsible for the development of congenital goiter remains unknown.

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SUMMARIO IN INTERLINGUA

Struma Congenite

Es presentate tres casos de struma congenite, insimul con un discussion del constatationes roentgenologic e clinic, del pathologia, del etiologia, e del tractamento. Es includite un revista del litteratura. Le autores crede que lor reporto es le prime de su genere que appare in le litteratura radiologic de lingua anglese.

Le patiente con struma congenite nasce con un massa in le region thyroide que es usualmente molle e symmetric. Le symptomas varia in dependentia del magnitude e del sito del crescentia. Angustia respiratori con cyanosis es commun.

Le examine roentgenologic revela un massa a contorno lisie de tessuto molle in le area thyroide. Illo circumjace le trachea e a vices comprime e displacia le esophago. In un del casos del autores le curva normal del spina cervical pareva esser revertite per le pression del massa. Attention debe esser prestate a que le interpretation es basate solmente super pelliculas exponite in stato de inspiration complete, proque le trachea de infantes normal se arca in avante durante le expiration, e isto produce le impression de un tumescentia retrotracheal de tessuto molle. Studios roentgenologic esseva executate in duo del casos del autores.

Morbo thyroide del matre e le ingestion de drogas strumogene per le matre, le action strumogene de calcium in areas a basse nivellos de iodo, e le "zonas geographic de struma" es discutite in relation al etiologia. In un del presente casos, nulle medication de character strumogene habeva essite administrate al matre. In le altere casos il esseva supponite que le matres esseva hyperthyroide, sed iste supposition non es demonstrabile proque le usual tests de laboratorio es deceptive durante pregnantias. Es formulate le conclusion que le exacte mechanismo que es responsabile pro le disveloppamento de struma congenite remane incognoscite.

The Effect of Radiation on the Esophagus

A Clinical and Histologic Study of the Effects Produced by the Betatron[1]

WILLIAM B. SEAMAN, M.D., and LAUREN V. ACKERMAN, M.D.

IT HAS BEEN repeatedly shown that with supervoltage equipment it is possible to damage deep-seated organs without injuring the skin. The total dosage that can be delivered to a neoplasm is thus no longer dependent upon skin tolerance but upon the tolerance of deep-lying tissues in the path of the beam. Since any tissue can be destroyed by radiation, the definition of radioresistance is a relative matter; in the past it has been defined chiefly in relation to skin tolerance. Since the advent of supervoltage therapy, there is an urgent need for quantitative knowledge regarding the dose of radiation that the different tissues can tolerate without irreversible changes that result in serious loss of function.

In our experience in the treatment of intrathoracic cancer with the betatron, a major limiting factor has been the tolerance of the esophagus. During the past two years, among the patients whom we have treated for carcinoma of the lung, there were 20 who could not be adequately treated without inclusion of the esophagus within the irradiated volume. With one exception, none of this number had known esophageal extension of their disease or dysphagia prior to therapy. All exhibited clinical evidence of radiation esophagitis of varying degree. In 11 patients, the reaction was considered to be mild. This consisted of slight to moderate substernal burning beginning usually in the third week of therapy and continuing for several weeks after the completion of treatment. The pain was not severe enough to interfere seriously with nutrition but frequently required some dietary modification. Four experienced moderately severe reactions characterized by more severe pain on swallowing and lasting for two to three months after the end of therapy. Five severe reactions were manifested by marked dysphagia and the development of permanent organic strictures requiring dilatation. In 2 instances, a tracheo-esophageal fistula developed.

The time of initial appearance of the dysphagia varied from the twelfth to the thirtieth day after the initiation of therapy, after the esophagus had received doses varying from 2,000 to 2,500 r in two weeks to 4,000 to 4,500 r in four weeks. The dysphagia was characterized by substernal burning following the ingestion of either solid or liquid food and lasting for several minutes or more after each swallow. In a few instances, there was only an awareness that food was passing down the esophagus. In more severe cases, the pain radiated into the chest and up into the neck and post-auricular region.

Most of these patients were treated in 1954, when all of the available clinical data and animal experiments indicated that the 24-MEV x-ray beam produced by the betatron was biologically less efficient than 200-kv x-rays. At that time the report of Quastler and others (3, 4, 12, 14–18) indicated that the relative biologic efficiency for 24-MEV x-rays was from 0.6 to 0.8. On this basis, a dose of 7,500 r delivered with a betatron would be approximately equivalent to 6,000 r from conventional equipment. More recent experimental data (1, 10) suggests that the relative biologic efficiency is close to unity, and this coincides with our clinical impression.

Roentgenographic studies during the period of the acute esophagitis were frequently negative, although occasionally fine serrations of the margin of the barium

[1] From the Edward Mallinckrodt Institute of Radiology, and the Division of Surgical Pathology, Washington University School of Medicine, St. Louis, Mo. Presented at the meeting of the Association of University Radiologists, May 1956, Rochester, N. Y. Accepted for publication in November 1956.

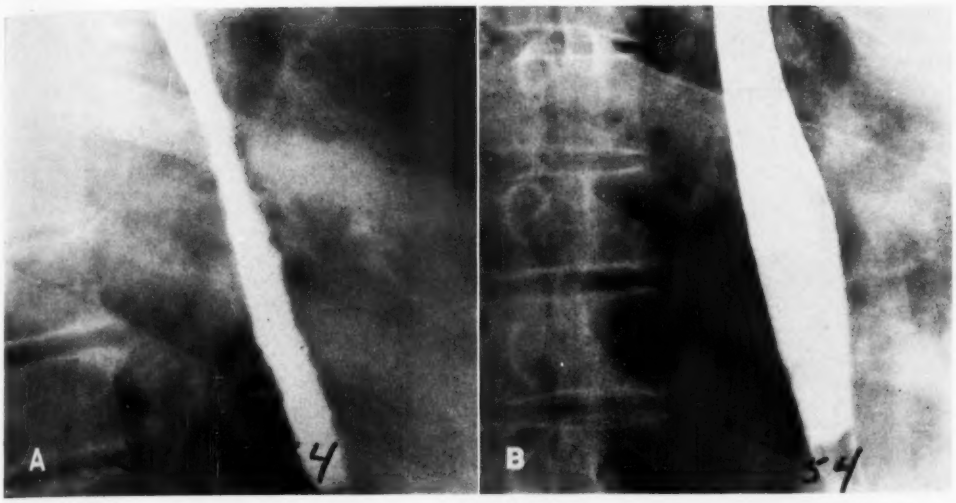

Fig. 1. Patient M. G. A. Acute radiation esophagitis. Note the irregular, serrated margins of the barium column, with slight narrowing of the lumen. B. Complete return to normal six months later.

column could be demonstrated (Fig. 1). Thickening of the rugal folds limited to the irradiated area was also observed. The most common finding was the development of constrictive narrowing of the lumen, first detectable in the third or fourth month after the completion of treatment (Fig. 2).

A review of the medical literature has revealed relatively little about the effects of radiation on the esophagus. Desjardins (5), in a review article written in 1931, stated that "the situation of the esophagus undoubtedly affords exceptional protection from injury by irradiation, but, aside from this, the specific radiosensitiveness is not great. Few injuries of this structure have been recorded and consequently its sensitiveness has not been subjected to experimental investigation." In 1934, Engelstad (7) studied the histologic changes in the esophagus and trachea of dogs subjected to varying doses of radiation. Following large doses, he observed degenerative changes in the esophageal mucosa and even entire loss of epithelium, although this was usually followed by complete epithelial regeneration. Freid (9) described a patient with dysphagia following irradiation of an esophageal cancer in whom only radiation fibrosis and stenosis were found at autopsy. Nielsen (13) also mentioned a patient with

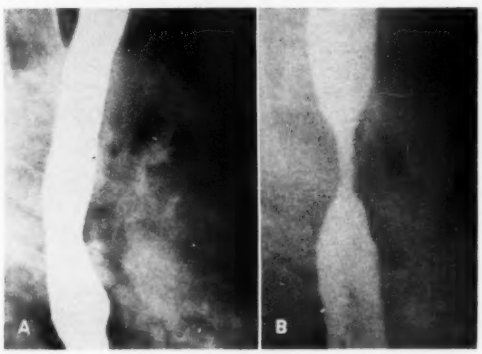

Fig. 2. Patient L. N. Development of esophageal stenosis four months after betatron therapy for carcinoma of the left main bronchus; 5,100 r depth dose in twenty-two days. A. January 1955. B. July 1955.

an esophageal carcinoma who was successfully treated by irradiation but who subsequently developed a cicatricial stenosis. He reported partial replacement of the muscularis by fibrous tissue in 5 autopsied cases in which there was no evidence of residual cancer.

We had the opportunity to study some of the irradiated esophagi histologically eight to twelve months after the completion of therapy. The skin-sparing effect of this type of high-energy radiation was confirmed microscopically by absence of radiation changes in the epidermis and

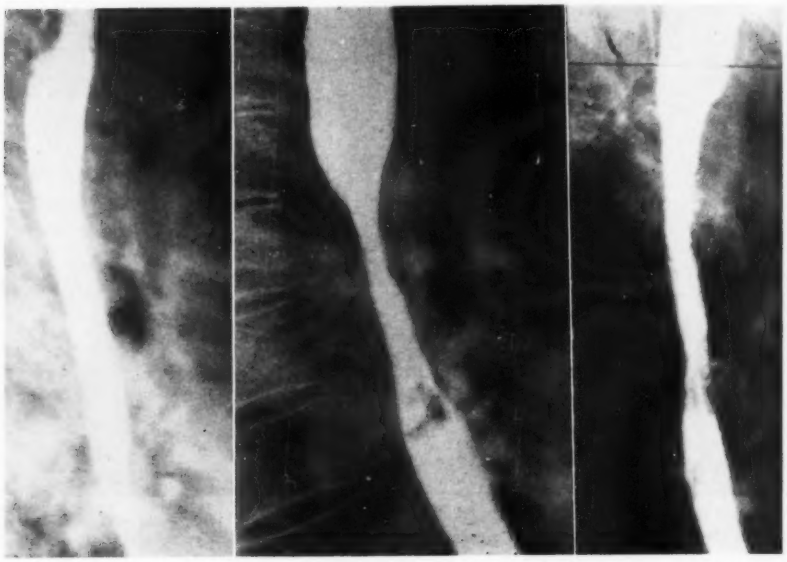

Fig. 3. Patient R. B. Serial films of the esophagus at two-month intervals, demonstrating progressive narrowing of the lumen. A depth dose of 7,300 r was delivered in forty-eight days. First barium swallow was taken one month after the completion of therapy.

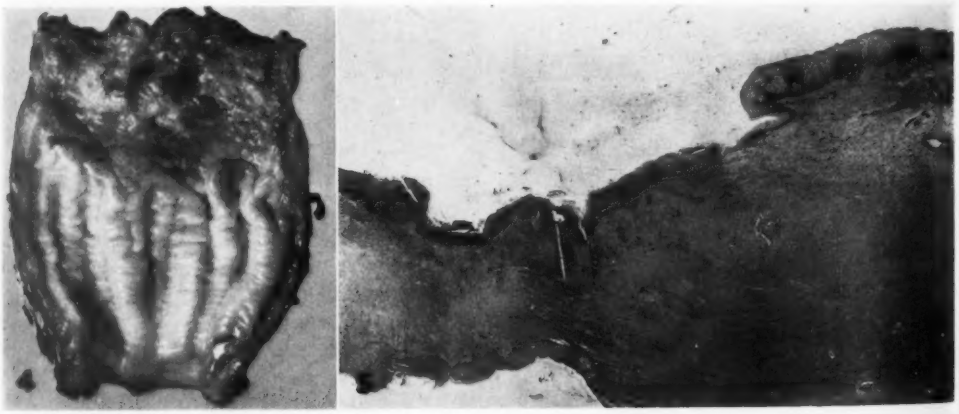

Fig. 4. Patient R. B. Surgical specimen showing area of radiation necrosis and complete loss of epithelium. Note sharp demarcation between the severe and the mild radiation effect.

Fig. 5. Patient R. B. Microscopic section of specimen shown in Fig. 4, illustrating the sharp delineation between intact squamous epithelium and the area of radionecrosis. Note the marked thickening of the submucosa beneath the portion with intact epithelium.

subcutaneous tissues. The following cases demonstrate some of the characteristic microscopic changes.

R. B., a 42-year-old male, had a carcinoma of the left main bronchus and paralysis of the left vocal cord. He was treated through six 6 × 10-cm. portals, a total tumor dose of 7,300 r being delivered in forty-eight days. Dysphagia began at the end of the third week of irradiation, after 3,250 r had been given, and became progressively severe during the rest of the treatment period. For two months after the completion of therapy, swallowing improved but there developed acute episodes of complete esophageal obstruction, relieved by parenteral Pro-Banthine. Serial roentgenographic studies disclosed progressive narrowing of the esophagus in the treated area (Fig. 3). This became so severe

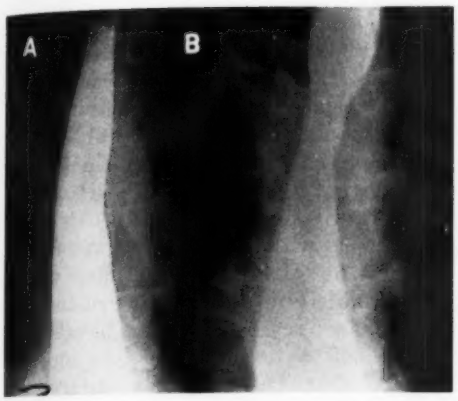

Fig. 6. Patient J. C. A. Normal barium swallow three months after the completion of therapy. B. Minimal constriction of the lumen eight months after completion of therapy. Patient had mild dysphagia during treatment which completely disappeared in one month and did not recur.

that a palliative partial esophagectomy was performed.

The gross specimen showed complete absence of mucosa and partial destruction of the muscular layer in a 3-cm. area (Fig. 4). In the rest of the irradiated portion there was thickened mucosa arranged in prominent longitudinal folds, with sharp demarcation between the area of severe and of mild radiation damage that was in keeping with the well defined physical collimation of the betatron beam. This was also well demonstrated in microscopic sections, which showed a sharp delineation between intact squamous epithelium and the area of severe radiation effect (Fig. 5).

J. C., a 36-year-old female with an adenocarcinoma of the right upper lobe, was treated with the betatron through three 9 × 15-cm. fields, for a tumor dose of 7,600 r in thirty-six days. On the twenty-first day, when 4,000 r had been delivered, substernal pain after swallowing first appeared. Mild dysphagia continued during the rest of the treatment period and did not entirely disappear until one month after the completion of therapy. A barium swallow three months after treatment was negative (Fig. 6), but eight months later a mild diminution in the caliber of the esophageal lumen was demonstrated, although the patient denied any swallowing difficulty. Death occurred one month later from pulmonary hemorrhage.

Microscopic examination showed marked thickening of the esophageal wall that seemed to be due largely to a tremendous widening of the submucosa (Fig. 7). This change appears to be relatively specific and parallels to some degree changes seen in the submucosa of the small intestine. Abnormalities were also noted in the muscle, consisting of edema and abnormal nuclei with vacuolization

Fig. 7. Patient J. C. Photomicrographs, at same magnification (×10), of normal unirradiated esophagus (A) and the irradiated esophagus (B) Note the tremendous submucosal thickening.

of the cytoplasm (Fig. 8). In other areas, the radiation effects were extremely severe. The muscle had a smudged appearance with loss of nuclear detail and absence of cellular delineation that we have termed homogenization (Fig. 9), probably similar to the hyaline changes in the contractile elements and gelatinous changes in the intermuscular stroma described by Warren and Friedman (19). These muscular changes seemed to be primary and not secondary to vascular damage. The absence of clinical symptoms referable to the swallowing function is rather surprising in view of the marked degenerative changes in the esophageal wall.

It seems likely that during irradiation there is first destruction of epithelium and then, with waning of the radiation effect, as in other epithelial-lined tissues, regeneration of the lining membrane. This is

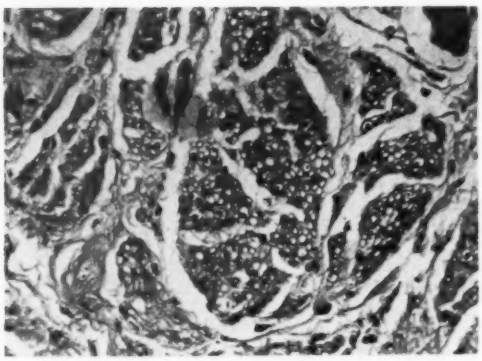

Fig. 8. Patient J. C. Photomicrograph of esophageal muscle (×215) showing abnormal nuclei, vacuolization of the cytoplasm, and edema separating muscle bundles.

exactly what Engelstad found in the dog's esophagus following large doses of radiation. Thus it is not too surprising to see relatively normal appearing epithelium in many of these heavily irradiated esophagi. We have been impressed by the extremely prominent changes in the submucosa, which seem to be so very characteristic. The changes in the muscle have been the most remarkable, since muscle is supposed to be an extremely radioresistant tissue. It is probable that the critical level of radiation that can be tolerated by the esophagus is dependent upon the tolerance of submucosa and muscle. This is in accordance with the suggestion of Ellis (6) that the tolerance dose of most tissues is determined by the tolerance of the vasculo-connective tissue. The blood-vessel alterations were minimal and do not suggest that the radiation injury was secondary to vascular damage, but rather a direct effect on muscle, connective tissue, and epithelium.

The dose delivered to the esophagus was high but was predicated on low relative biologic efficiency. A reduction in total dosage has decreased the severity of these reactions. A total depth dose of 6,000 r given at a rate of 1,000 r a week seems to be about the upper limit of tolerance. This

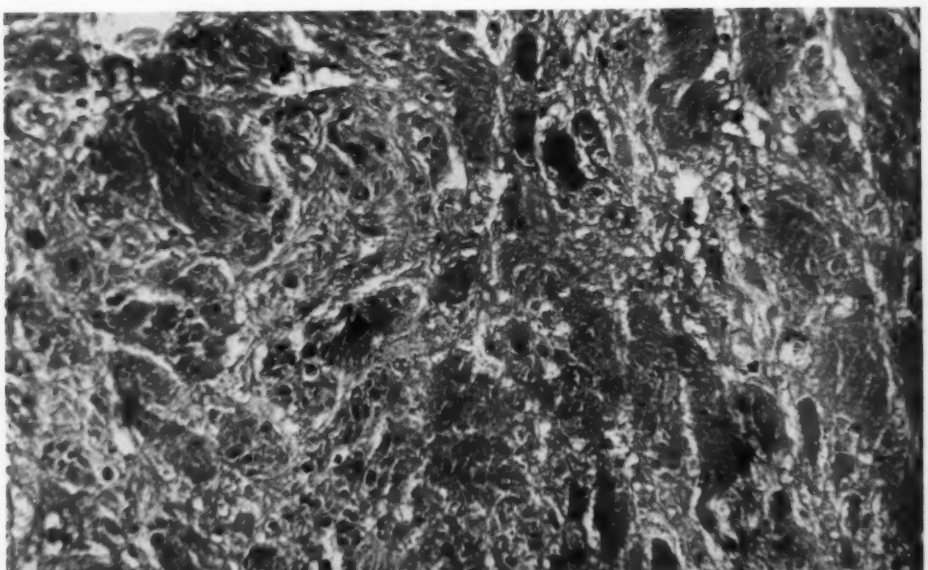

Fig. 9. Patient J. C. Severe effect of radiation on muscle, with loss of nuclear detail and absence of cellular delineation. These changes seem to be primary and not secondary to vascular damage. There were no clinical symptoms referable to the swallowing function.

agrees fairly well with Ellis' estimate of the tolerance of the vasculo-connective tissue for small fields (6).

An attempt was made to correlate the severity of the reactions with the total dose and the time (Fig. 10). Although the correlation of dose with incidence of complications is not close, one gains the impression that the total dosage is more important than the time during which it is delivered. Four of the 5 patients with severe reactions received 6,500 to 7,500 r in periods of thirty to fifty days. Three of the 4 patients with moderately severe reactions received over 6,000 r in thirty to forty days. When, however, the treatment time is standardized according tc the cube-root formula postulated by Bond (2), one finds little variation in dose. This suggests that the patients in whom severe esophageal complications developed may have been unusually radiosensitive. All of the patients in this group had direct or indirect evidence of mediastinal invasion. Consequently, there could have been actual invasion of the esophageal wall, or it may be that the presence of mediastinal tumor affects the radiosensitivity of the esophagus.

All doses were calculated from standard depth-dose tables for 24-MEV radiation based on measurements taken in a water phantom. These figures are not valid for air-containing lung of much lower density, and consequently the actual dose probably was significantly higher than the calculated dose.

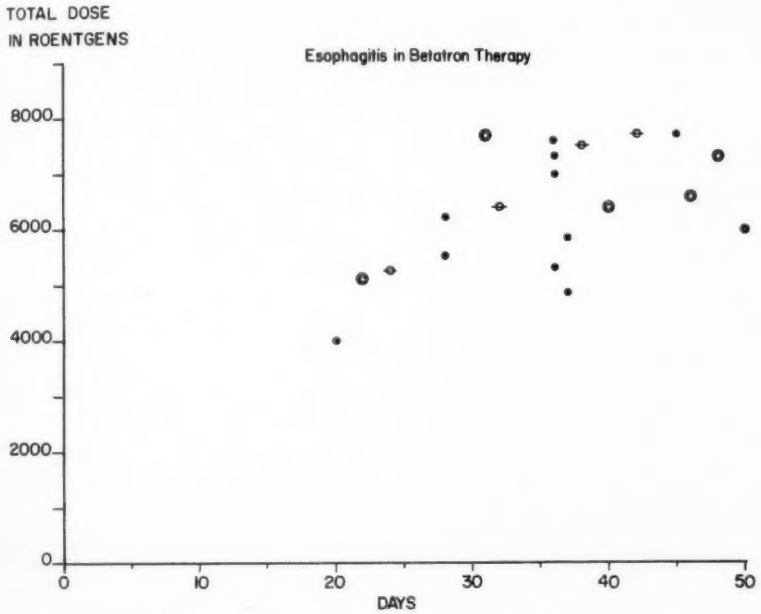

Fig. 10. Correlation of severity of esophageal reactions with radiation dose and time factors. Double circles indicate patients with severe complications (marked stenosis, persistent dysphagia, or tracheo-esophageal fistula); circles with horizontal line represent moderately severe reactions, and the solid dots those with mild esophagitis.

We have had relatively little difficulty with esophagitis in treating 18 cases of carcinoma of the esophagus. This group, however, is much more difficult to evaluate clinically, since practically all of these patients have dysphagia initially due to their disease. Since their swallowing usually improves during therapy, as the tumor regresses, it may be that this improvement overshadows the substernal burning produced by the esophagitis.

SUMMARY

1. Some degree of radiation esophagitis is frequent if the esophagus is included within the irradiated volume during intensive betatron therapy.

2. The most frequent radiological finding is narrowing of the esophageal lumen.

3. Histologic abnormalities are most profound in the muscle and submucosa.

4. It is our impression that the maximum tolerance dose for the esophagus is a total of 6,000 r given at a rate of 1,000 r per week.

5. Our clinical experience is more in accord with the recent experimental work that assigns to 24-MEV radiation a relative biological effect of approximately one.

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SUMMARIO IN INTERLINGUA

Effecto de Radiation Super le Esophago: Un Studio Clinic e Histologic del Effectos Producite per le Betatron

Un major factor limitatori in le tractamento de cancere intrathoracic per medio del betatron ha essite le effecto super le esophago. In un serie de patientes tractate pro carcinoma del pulmon in le curso de un periodo de duo annos, il habeva 20 in qui il esseva impossibile tractar le tumor adequatemente sin includer le esophago in le volumine irradiate. Omne iste 20 patientes exhibiva certe signos de esophagitis durante o post le irradiation. In 11, le reaction esseva leve, consistente de minor o moderate arditura substernal que comenciava usualmente le tertie septimana del therapia e continuava plure septimanas post su completion. Quatro patientes experientiava plus sever dolores que durava duo o tres menses post le completion del therapia. Le remanente 5 patientes habeva sever reactiones, manifeste in dysphagia

marcate e in le disveloppamento de stricturas que requireva dilatation. In 2 casos il habeva un fistula tracheo-esophagee.

Le plus frequente constatation radiologic post le irradiation esseva un restriction del passage esophagee. Alterationes histologic esseva le plus marcate in le musculo e le tessuto submucosal.

Le impression del autores es que le dose de toleration maximal pro le esophago es un total de 6.000 r in ratas de 1.000 r per septimana. Lor experientia clinic tende a corroborar le recente investigationes experimental que ascribe al radiation con 24 MEV un relative effecto biologic de approximativemente un.

Roentgen Criteria of Impending Perforation of the Cecum[1]

LEONARD DAVIS, M.D., and ROBERT M. LOWMAN, M.D.

IT IS THE PURPOSE of this paper to develop the concept of impending perforation of the cecum as a diagnostic entity which can be established simply and accurately by routine roentgen examination of the abdomen. It is important to be forewarned of the imminence of cecal perforation since, once this has occurred, the mortality rate of 70 per cent is unaffected by direct therapeutic effort (1, 15).

The clinical signs and symptoms of impending perforation of the cecum (3, 10, 11, 13) are listed in Table I. Because of their variability, these do not furnish a reliable basis for diagnosis. The roentgen evaluation of cecal size, on the other hand, provides a means of anticipating this emergency in large bowel obstruction. Beyond a critical point of size, perforation is imminent, whatever else may be suggested by the history, physical examination, or laboratory findings.

TABLE I: PRESENTING CLINICAL SIGNS AND SYMPTOMS OF IMPENDING CECAL PERFORATION

1. Constipation
   (*a*) Usually chronic
   (*b*) Often progressing to obstipation during week prior to hospitalization
   (*c*) Occasionally, as in lesions of the sigmoid, alternating with episodes of diarrhea
2. Abdominal Pain
   (*a*) Poorly localized
   (*b*) Often associated with meteorism
   (*c*) Usually colicky and transient in period prior to admission
3. Abdominal Distention
   (*a*) Usually progressive
   (*b*) Abdomen usually soft
   (*c*) Often non-tender, though tenderness in right lower quadrant may indicate compromised vitality of cecum
4. Vomiting
   (*a*) Often absent despite distention
   (*b*) When present, may be secondary to (1) small bowel distention or (2) peritonitis or (3) may be reflex, initiated by large bowel distention alone
5. General Appearance
   (*a*) Patients often do not appear very ill, but the entire range to *in extremis* is represented
6. Temperature
   (*a*) Range to about 100° in absence of perforation
   (*b*) Not necessarily elevated after perforation
7. Leukocyte Count
   (*a*) Range from 5,000 to 12,000.
   (*b*) Differential count may show shift to left
   (*c*) Response to perforation appears more dependent upon age of patient than state of inflammation
8. Melena
   (*a*) Relatively infrequent

MATERIAL

Nineteen cases of cecal distention with distal large bowel obstruction, collected over a ten-year period, were studied roentgenographically, and the findings confirmed at surgery or postmortem. Comparative findings were obtained from a review of 79 cases described in the literature as diastatic perforation of the cecum. A control group was provided by experimental evaluation in 100 patients of the limits to which the cecum could be distended artificially. The range of cecal size in this control group was compared with that in the 19 patients in whom large bowel obstruction was the etiologic factor.

MORBIDITY; MORTALITY; CRITERIA

Neither the agent nor the site of the large bowel obstruction is related to the subsequent course of cecal distention. In the series reported here, the number of patients with impending perforation was almost twice the number with complete perforation: 12 to 7 (Tables II and III). Among the 79 cases from the literature (8, 11, 14), on the other hand, there was a striking preponderance of complete perforation—13 cases to 1 of impending perforation. This difference may be attributed to early roentgen diagnosis in our series. The previously reported cases were diagnosed chiefly at autopsy.

The immediate hospital mortality is intimately related to the integrity of the mucosa. The prognosis is best with the

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TABLE II: SEVEN CASES OF CECAL PERFORATION

Case	Age (years)	Greatest Transverse Diameter of Cecum (cm.)	Primary Lesion	Procedure	Aftermath of Hospitalization
1	81	9.2	Carcinoma of rectosigmoid	Cecostomy	Recovery
2	84	9.7	Volvulus of sigmoid	Cecostomy	Death
3	29	9.8	Carcinomatosis of adrenal	Glass rod cecostomy	Death
4	50	11	Carcinoma of sigmoid	Cecostomy	Death
5	82	11	Carcinoma of splenic flexure	Cecostomy	Recovery
6	82	12.5	Incarcerated femoral hernia	Cecostomy	Death
7	79	13	Carcinoma of hepatic flexure	Transverse colostomy	Death

TABLE III: TWELVE CASES OF IMPENDING PERFORATION OF CECUM

	Age (years)	Greatest Transverse Diameter of Cecum (cm.)	Primary Lesion	Procedure	Aftermath of Hospitalization
1	70	9.0	Carcinoma of rectosigmoid	Cecostomy	Recovery
2	74	9.0	Carcinoma of sigmoid	Cecostomy	Recovery
3	75	9.5	Volvulus of sigmoid	Surgical reduction	Recovery
4	72	9.5	Carcinoma of transverse colon	Double-barreled colostomy	Recovery
5	49	9.6	Carcinoma of sigmoid	Cecostomy	Recovery
6	34	10.1	Volvulus of sigmoid	Surgical reduction	Recovery
7	64	11.3	Carcinoma of splenic flexure	Cecostomy	Recovery
8	81	11.5	Carcinoma of rectosigmoid	Cecostomy	Recovery
9	76	12.0	Carcinoma of descending colon	Cecostomy	Recovery
10	87	12.5	Carcinoma of splenic flexure	Cecostomy	Death on 53rd hospital day with extensive metastases
11	79	14.2	Carcinoma of transverse colon	Cecostomy	Recovery
12	68	16.3	Diverticulitis	Cecostomy	Recovery

mucosa intact, becoming almost hopeless with mucosal disruption. There were 5 deaths among our 7 cases of complete perforation and 1 among the 12 patients in whom perforation had been considered imminent at the time of surgery. Since therapeutic measures were practically identical in the two groups, the possibility that different modes of treatment were responsible for the difference in immediate mortality can be discounted (Tables II and III).

The upper limit of cecal size was determined, as mentioned above, by artificial distention of the cecum with barium and air in 100 selected patients without intrinsic cecal disease or distal large bowel obstruction. The greatest transverse diameter was measured on a prone film in each of the 100 patients. A graphic representation of the 200 measurements produced a bell-shaped curve, with the diameter of the cecum 9 cm. in 97 cases (Fig. 1A). In the 19 cases with obstruction, the cecal size, as measured on the prone film, ranged from 9 to 16.3 cm., with none under 9 cm. (Fig. 1B). From this comparison, 9 cm. was arbitrarily established as a critical point of reference. Distention beyond this critical measurement warned of the danger of perforation.

Roentgen signs of perforation and peritonitis were evident when the mucosa of the cecum had ruptured, and this formed the basis for the diagnosis of complete perforation. Cecal size alone was not an indication of complete perforation. In the latter event, the cecum was not significantly larger or smaller than in impending perforation, (Fig. 1B).

APPLICATION OF ROENTGEN CRITERIA

If, in the presence of a large bowel obstruction, the greatest transverse diameter of the cecum measured 9 cm. on the

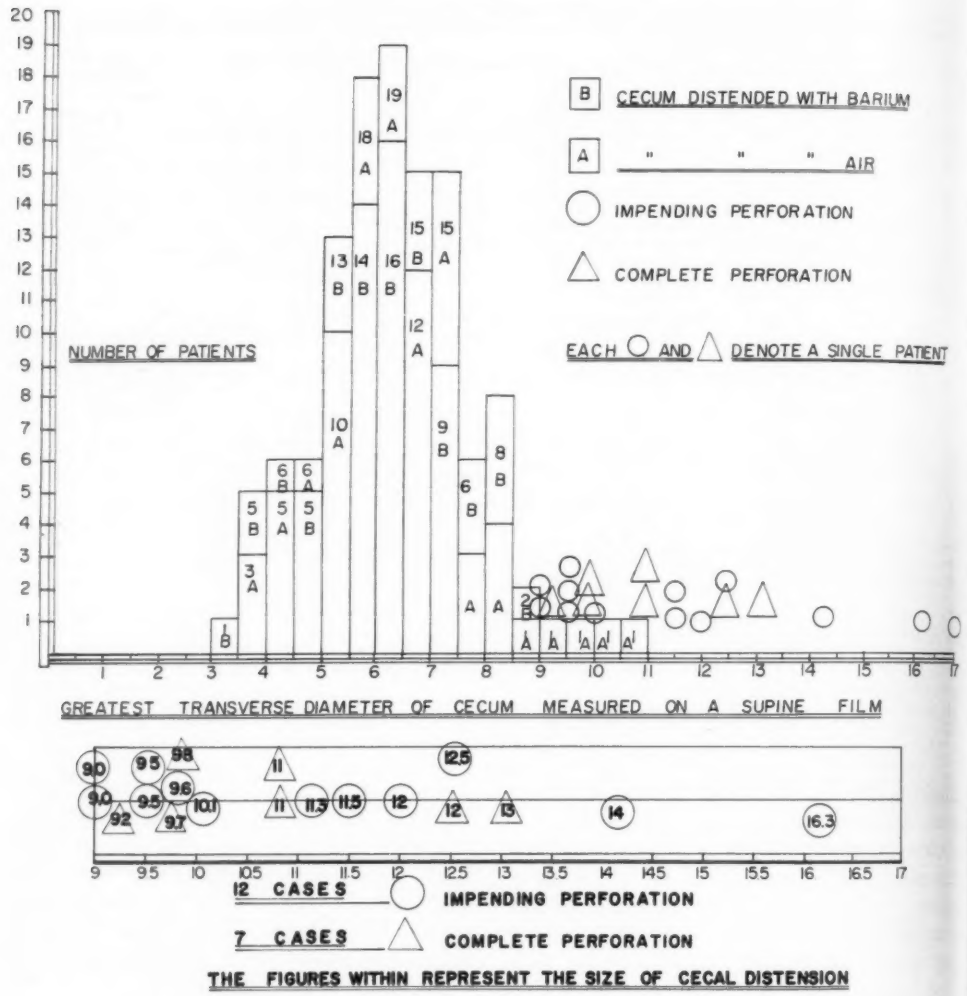
B CECUM DISTENDED WITH BARIUM
A " " " AIR
IMPENDING PERFORATION
COMPLETE PERFORATION
EACH ○ AND △ DENOTE A SINGLE PATIENT
NUMBER OF PATIENTS
GREATEST TRANSVERSE DIAMETER OF CECUM MEASURED ON A SUPINE FILM
12 CASES IMPENDING PERFORATION
7 CASES COMPLETE PERFORATION
THE FIGURES WITHIN REPRESENT THE SIZE OF CECAL DISTENSION

Fig. 1. Graph A (above) represents the range of cecal size in the 100 control patients compared with the range of size in the 19 patients with large bowel obstruction and cecal distention.

The measurements in the control group were taken after distention with barium and with air in patients who had neither intrinsic disease of the cecum nor large bowel obstruction. Within this group, the greatest number of measurements fell between 5 and 7 cm.

Graph B (below) is an enlargement of the outer portion of Graph A, illustrating the abnormal range of cecal distention in the 19 patients with impending or complete perforation of the cecum.

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prone film, the diagnosis of impending perforation was made to emphasize that the intact state of the cecal mucosa was threatened. Pneumoperitoneum or signs of peritonitis indicated that the process had extended through the mucosa (Figs. 2–5).

Although a larger amount of free gas is to be expected with perforation of the large bowel than of other parts of the intestinal tract (5, 12), its visualization is not without difficulty. The absence of demonstrable free air lends greater importance to the roentgen definition of the psoas shadows, the properitoneal fat lines, and the form and situation of the bowel loops. Small

bowel distention was found with and without complete perforation and represented the balance of many variables. The essential roentgen guides are the size of the cecum and evidence of peritonitis and perforation.

DYNAMICS OF PERFORATION

Primary factors in the course of cecal perforation in distal large bowel obstruction are the state of the ileocecal valve and mechanical over-distention (2, 7, 9, 10, 11, 13, 16). Ischemia, increased virulence of bacterial flora, and biochemical changes (6) occupy more poorly defined roles.

Fig. 2. O. H., female aged 50, was hospitalized on April 2, 1937, because of severe non-radiating pain in the right groin for three days, accompanied by increasing abdominal distention and obstipation. Nausea had been followed by frequent vomiting. The patient appeared somewhat obese and was in acute discomfort at admission. The distended abdomen was tympanitic, and active bowel sounds were heard. Pressure elicited lower quadrant tenderness. Temperature 99.8° F. W. B. C. 10,500.

The cecum measured 11 cm. in its greatest transverse diameter. Generalized opacification and loss of definition of the psoas shadows were consistent with the presence of free fluid. A companion radiolucent shadow along the medial margin of the distended cecum suggested dissection of the bowel wall by air.

Cecostomy, the day following admission, revealed generalized peritonitis with cecal perforation. The patient died on April 15. Adenocarcinoma of the rectosigmoid was found at autopsy.

Fig. 3. E. C., female aged 64, experienced progressive abdominal distention and obstipation, with anorexia and nausea, for five days before admission on Nov. 8, 1955. She had not vomited. She appeared wasted and ill. The abdomen was distended and tender in the right upper quadrant. Temperature 102° F. W.B.C. 8,600.

The greatest transverse diameter of the cecum measured 11.3 cm. on the supine film. No evidence of pneumoperitoneum or free fluid in the peritoneal cavity was demonstrable. Absence of small bowel distention was noted. The film study was interpreted as representative of impending perforation of the cecum. A barium-enema study disclosed an intussuscepted lesion in the left colon. The barium had been introduced cautiously, only to the site of the lesion. Cecostomy, performed later on the same day (Nov. 8), did not reveal peritonitis or cecal perforation.

Ten days later definitive surgery was undertaken for removal of an adenocarcinoma which had intussuscepted. The patient recovered and was discharged.

It has been accepted that an incompetent ileocecal valve, by permitting gas to back into the small bowel, prevents its accumulation within the cecum, thus forestalling distention and subsequent perforation (3, 9, 10, 12, 13, 16). But small bowel distention alone, in the presence of a markedly distended cecum, does not guarantee that the ileocecal valve is incompetent or that cecal perforation will not occur.

The estimates of the frequency of ileocecal valve incompetence range from 50 (11) to 90 per cent (4). If an incompetent valve acts merely as a vent to allow the

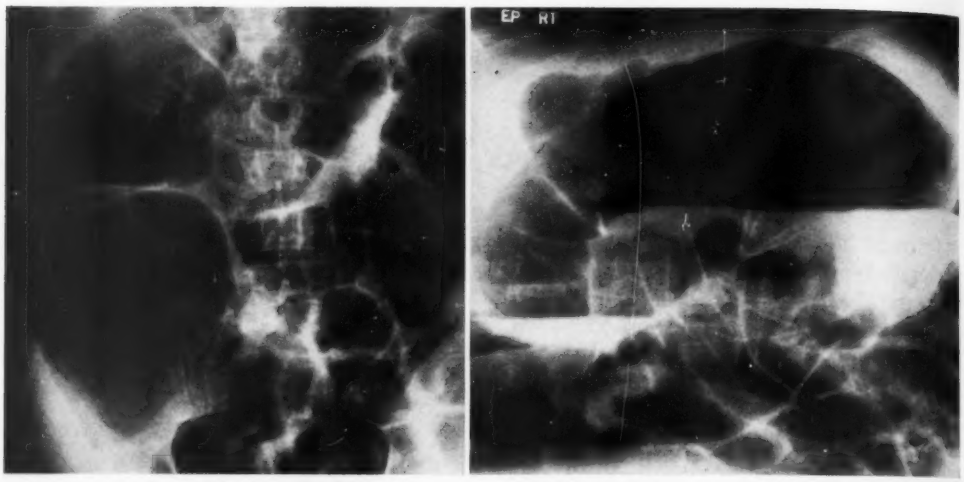

Fig. 4. E. O., male aged 82, was hospitalized on Dec. 5, 1955, after four days of anorexia, nausea, and slowly increasing abdominal distention associated with obstipation. No vomiting had occurred. Lower abdominal pain was diffuse, not cramping. A left inguinal bulge had become prominent. The patient had noticed several tarry, black stools, in the course of the preceding two months. He was in moderate distress. The distended abdomen was tympanitic but silent, and the bowel could not be outlined. Tenderness was minimal over the right lower quadrant. A left direct inguinal hernia was not reducible. Temperature 98° F. W.B.C. 21,500.

The cecum was distended to 12.5 cm. in its greatest transverse diameter. The psoas margins and properitoneal fat could not be visualized. A companion radiolucency could be traced along the lateral margins of the cecum and the inner and outer margins of the walls could be delineated. The presence of free air thus suggested on the supine film was confirmed by a decubitus view. The opaque finger-like projections along the bowel walls were believed to represent the invasion of free fluid.

Operation, on the day of hospitalization, revealed generalized peritonitis, with a perforation of the cecum along the anterior taenia, walled off by adhesions. Cecostomy was done and an incarcerated femoral herniation on the left was revealed—not strangulated. Death occurred within the week.

equilibrium of pressures between the large and small bowel, then cecostomy performed prior to perforation should be even more successful in reducing the size of the distended cecum. In many instances, however, no significant change in cecal size has been observed for more than five days after cecostomy (9). The complexity of decompression is demonstrated by a single report of cecal perforation taking place soon after completion of a transverse colostomy (10).

The absence of small bowel distention is a useful observation from which competence of the ileocecal valve can be inferred. The

Fig. 5. F. T., male, aged 79, was admitted on Oct. 13, 1947, with a history of cramping abdominal pain and obstipation for four days. He had noticed a progressive weight loss for one year. He was acutely ill, with a distended, tympanitic, silent abdomen. Temperature 100° F. W. B. C. 12,300.

The cecum measured 14.2 cm. in its greatest diameter. Unequivocal evidence of peritonitis or pneumoperitoneum could not be distinguished, and the diagnosis of impending perforation was made.

Cecostomy on the day of admission revealed an area of extreme thinning over the anterior mid-cecum, about 2.5 cm. in diameter, with splitting only of the anterior taenia. Free fluid was not observed. An adenocarcinoma of the transverse colon was demonstrated on Nov. 4, at the time of definitive surgery.

picture may then resemble a closed-loop obstruction, in which the cecum appears enormous by contrast.

Mechanical over-distention is accepted as a common cause of cecal perforation. The particular susceptibility of the cecum to perforation, among the areas of the large bowel, has been observed clinically and has been demonstrated by the forced distention of isolated loops of the bowel experimentally (16). Hypertrophy of the circular muscle layer in the region proximal to a slowly progressing obstruction is common and may assist in making this area less susceptible to strain, (7).

None of the factors, taken alone, explains the complete picture. In combination, they afford a background against which the problem of perforation can be better understood roentgenographically.

SUMMARY

Measurements were made of the greatest transverse diameter of the cecum on a prone film of the abdomen in 19 cases of large bowel obstruction with cecal distention and in 100 controls without obstruction, in whom distention was induced artificially by the injection of air and barium. On this basis, 9 cm. was established as the critical diameter beyond which danger of perforation exists.

The reduction in mortality when therapeutic measures are instituted before complete perforation, while the cecal mucosa is still intact, indicates the need of a criterion of this nature.

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SUMMARIO IN INTERLINGUA

Criterios Roentgenologic de un Perforation Imminente del Ceco

Il es importante esser premonite quando un perforation cecal es imminente in le presentia de un obstruction del intestino crasse, proque post le occurrentia del perforation le mortalitate es alte in despecto de omne mesuras therapeutic. Pro establir un criterio roentgenologic pro le diagnose de perforation imminente, mesurationes del plus grande diametro transverse del ceco in pelliculas pron esseva

obtenite pro 19 patientes con obstruction del intestino crasse distal. Istos esseva comparate con simile mesurationes in 100 patientes sin obstruction sed con distension artificial del ceco inducite per injectiones de barium e aere. Per iste methodo, 9 cm esseva establite como le diametro critic in ultra de que on pote dicer que un perforation es imminente.

Le 19 casos in le serie del autores include 7 in que le perforation esseva recognoscite como complete al tempore del operation. Solmente 2 de iste 7 superviveva le periodo immediatemente postoperatori. Il occurreva solmente 1 morte postoperatori inter le 12 casos in que le operation esseva interprendite con un diagnose de perforation imminente.

A Photographic Personnel Dosimeter for X-Radiation in the Range from 30 kev to Beyond 1 MEV[1]

MARGARETE EHRLICH, Ph.D.

INTRODUCTION

Biological Considerations: When used for x-ray dosimetry, photographic film is at best a rough, secondary instrument. It has to be calibrated against primary standards, processed under controlled conditions, and, if possible, placed in a special holder designed to produce a suitable film response as a function of radiation energy.

Ideally, the response of a radiation dosimeter should parallel closely the radiation damage to biological tissue. For the tactical radiation dosimeters used by the Military, the biological damage criterion usually selected is the lethal effect of the radiation on mammals. In the case of x-rays, the lethal exposure as measured in roentgens in free air was found to increase sharply below about 80 kev (1).

A sharp drop of dosimeter response below this energy is therefore sometimes thought to be desirable for tactical x-ray dosimetry. As most of the film dosimeters presently in use employ filters of high atomic number over at least a portion of the sensitive area (2, 3), they display this cut-off.

In civilian applications, biological criteria other than lethality apply, and damage to superficially located biological structures must be considered. It is now believed that, for most types of biological action, the effect of radiation is proportional to the amount of energy imparted to tissue along unit track length of the secondary ionizing particles (linear energy transfer) (4); also, it has been shown (5) that the linear energy transfer of electrons rises sharply as their energy decreases from 100 kev to 1 kev. If one assumes that for equal energy absorption per gram of tissue the relative biological effectiveness of x-rays below 100 kev does not decrease as the x-ray energy decreases, one may conclude that a response cut-off of a radiation dosimeter below 80 kev is undesirable for most civilian applications.

Aims and Accomplishments of Present Study: Groups concerned with personnel monitoring have frequently expressed a demand for a film dosimeter whose response to x-radiation of energy below 100 kev parallels more closely the energy absorption in biological tissue, or at least that in air (*i.e.*, the exposure in roentgens). The instrument described in this paper is, in part, an answer to this demand. Its response to x-radiation between 30 kev and 1 MEV lies within ± 20 per cent of that of air for exposures ranging from roughly 250 mr or less to about 3 r, and within ± 30 per cent for exposures ranging from about 3 r to 6 r. It is useful also for radiation energies higher than 1 MEV, although with slightly decreased accuracy, and its exposure range can be extended up to 600 r for high-energy emergency work.

PRINCIPLE OF FILM-STACK DOSIMETER

Basic Idea: The idea for the dosimeter here referred to as the "film-stack dosimeter" was first conceived by Allisy (6). In its present form, the dosimeter utilizes two film types in conventional dental film packets. The packets are placed in combination plastic-and-metal holders. The films and the holder components are so chosen that the response of the insensitive film (placed in the plastic portion of the holder) to low-energy radiation equals approximately that of the sensitive film (placed in the metal portion of the holder) to high-energy radiation. For the present study, it was convenient to use two commercial Du Pont film types. It is likely, however, that other pairs of film types might prove equally suitable. All films exposed in the same holder are stacked

[1] From the National Bureau of Standards. Work supported by the U. S. Atomic Energy Commission and the U. S. Army Signal Corps. Accepted for publication in September 1956.

TABLE I: CHARACTERISTICS OF EMPLOYED LOW-ENERGY SPECTRA

X-ray Tube	Exciting Potential (kv)	Added Filtration (mm.)	Location of Spectral Peak (kev)	Spectral Width at Half Height (kev)
50 kvcp	8	0.25 Al	7.3	0.6 (8%)
Beryllium window tube	15	2.0 Al	14	1.9 (14%)
1 mm. Be inherent filtration	30	0.23 Cu + 1.2 Al	28	4.5 (16%)
250 kvcp	30	1.6 Al	24	10 (42%)
Industrial tube	50	0.13 Pb	42	14 (32%)
Inherent filtration equivalent	100	0.52 Pb	75	28 (37%)
to 3 mm. Al	150	1.5 Sn + 4.8 Cu	120	50 (42%)
	250	2.7 Pb + 1.0 Sn + 0.62 Cu	210	42 (20%)

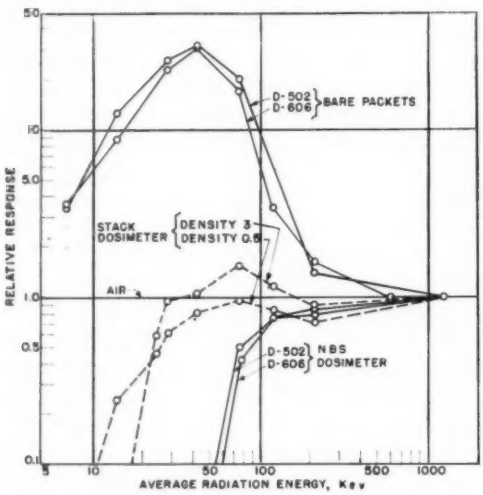

Fig. 1. X-ray response of bare film packets, NBS dosimeter, and stack-film dosimeter, relative to that of air. The data are normalized arbitrarily to the response to x-radiation of around 1 MEV.

upon each other after processing and their sum-density is determined and related to radiation exposure. The criteria for the choice of the film types and the holder material, as well as the principle of the dosimeter's operation, will be discussed in detail by referring to the experimental data for the two film types chosen for the present work.

Experimental Procedure: The experimental test procedure consisted of exposing suitable samples of the two film types, bare or in holders, to Co^{60} gamma rays and to narrow spectral bands of low-energy continuous x-radiation, processing the exposed film samples in x-ray developer, and interpreting their photographic density. The characteristics of the low-energy x-radiation spectra employed for the exposures are shown in Table I. The spectra were calculated by means of Kramers' theory (3). Spot checks with a scintillation spectrometer showed satisfactory agreement between the experimental and the calculated spectral shapes. The two criteria chosen to characterize the spectra were the location of the spectral peak and the spectral width at half height. The employed spectra were fairly symmetrical about the location of the spectral peak, and the energy of the peak was therefore nearly the same as the "effective" photon energy of the beam. Because the method by which this energy was obtained differs from the usual method for obtaining "effective" energies, reference is later made to "average" energy whenever a brief designation is required.

Influence of Film Holder on Energy Dependence: Figure 1 shows the response of the Du Pont film types 502 and 606 (later referred to as D-502 and D-606) as a function of average x-ray energy for different conditions of exposure and evaluation. The quantity plotted as ordinate is proportional to the reciprocal of the exposure in roentgens required for a given film density (unit density, unless otherwise indicated) and is usually referred to as relative sensitivity or relative response. The three distinct sets of response data shown in the figure were not all obtained on the same emulsion batches and therefore are suitable only for a qualitative comparison. The two curves marked "bare packets" are qualitatively characteristic for the x-ray response of photographic film in general: There is a high response peak between 30

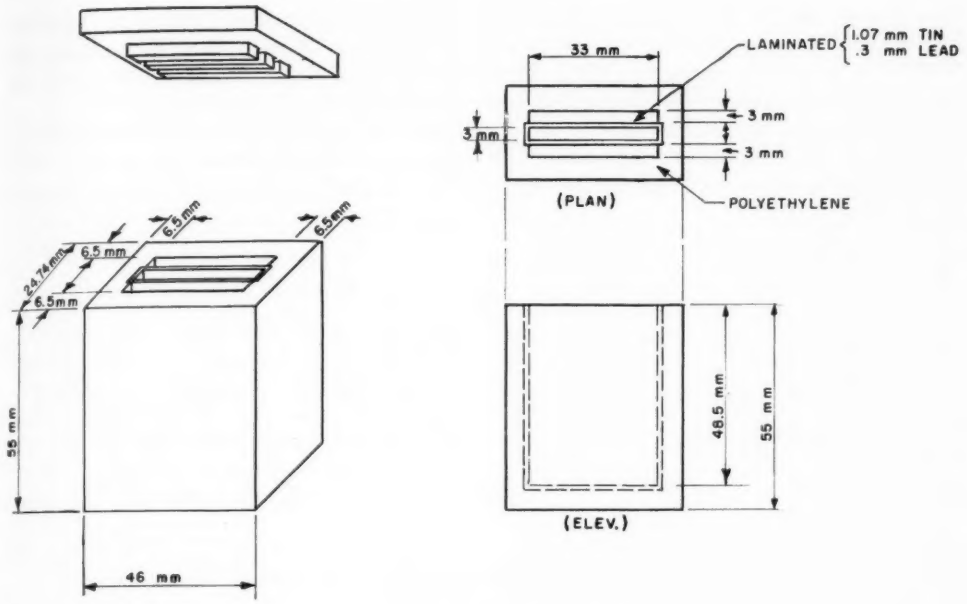

Fig. 2. The stack-film dosimeter holder.

and 40 kev, due to the strong absorption of radiation in this energy region by the silver halide in the film emulsion, and a fairly sharp drop in response below 25 kev and above 70 kev.[2]

If one desires to have the film response follow more closely that of air (see the line marked "air" parallel to the abscissa axis of Figure 1), one usually introduces metallic filters over the film surface, in order to have a large portion of the radiation to which the film is selectively sensitive absorbed in the metal. The curves in Figure 1 marked "NBS dosimeter" show how the response of the same two film types is modified by 1.07 mm. of tin adjacent to the film packet, overlaid by 0.3 mm. of lead (3). The response cut-off at about 80 kev is typical for the metal-covered area of current film dosimeters. Where a response to lower photon energies is desired, differential filtration—including an "open window" area—is sometimes introduced over the film surface. Such filtration furnishes means for a rough differentiation between various x-ray energies. Once the radiation energy is known approximately, the film density can be interpreted by means of a calibration curve obtained with x-radiation of similar energy. This procedure is cumbersome and can at times be quite inaccurate.

Figure 1 shows that an extension of the usefulness of film dosimetry to lower energies, without recourse to differential filtration, can be achieved with the film-stack dosimeter. The curves marked "stack dosimeter" were obtained by exposing the film types D-502 and D-606 in the special stack dosimeter holder illustrated in Figure 2. The D-502 film is inserted into the central tin-lead laminate case, while one D-606 film each is inserted in each of the two peripheral compartments formed by the walls of the polyethylene holder. Two D-606 films are employed, rather than one, in order to increase the symmetry of the dosimeter. The thickness of the polyethylene walls

[2] When monoenergetic x-ray sources are used to obtain the response curves, the course of the film response follows quite closely that of the silver- and bromine-absorption coefficients, showing distinct discontinuities at the K-absorption edges of these two elements (*i.e.*, at approximately 13.5 and 25.5 kev, respectively). See also reference 7.

was chosen so as to produce electronic equilibrium for x-radiation up to about 1 MEV. After processing, the three films belonging to one holder are stacked on top of each other for densitometry.

Choice of Films For Stack Dosimetry: In order to lend themselves well to film-stack dosimetry, the two film types should have the following properties:

1. The shape of their characteristic curves should be similar for identical processing. Figure 3 shows two sets of sample characteristic curves for the D-502 and the D-606 film types, one set obtained with radiation of 28-kev average energy, and the other with Co^{60} radiation.[3] The curves of the two chosen film types are fairly similar for lower densities. Unfortunately, the saturation density of D-606 is higher than that of D-502, which causes a larger inaccuracy for higher stack densities.

2. The response of the insensitive film to low-energy x-radiation should be about the same as that of the sensitive film at high energies. Figure 3 shows that this criterion is fairly well fulfilled for the film types D-606 and D-502. For lower densities, the characteristic curve of D-606 obtained with 28-kev average radiation energy almost coincides with that for D-502 obtained with Co^{60} gamma rays.

3. At any one radiation energy, the response of the sensitive film enclosed in a metallic holder should be as much lower than that of air as the response of the insensitive film, either bare or in an air-equivalent holder, is higher than that of air. The solid curves of Figure 1 show that this criterion is not quantitatively fulfilled for the film types D-502 and D-606, but that the agreement is, at least over a limited range of energies, within the range of accuracy required for personnel dosimetry.

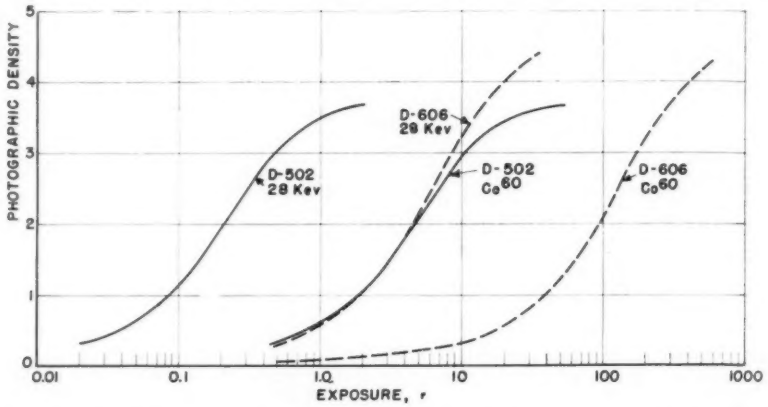

Fig. 3. The dosimeter components: sample characteristic curves; films developed in liquid x-ray developer for five minutes at 20° C.

Characteristic Curves of Film Stacks: Some of the characteristic curves resulting from stack dosimetry of the film types D-502 and D-606 are shown in Figure 4. At low x-ray energies, where the response of D-502 is suppressed by the metallic filters, the stack-characteristic curve (28-kev stack curve of Fig. 4) resembles that of D-606. At high energies, the response of D-606 is very low throughout the useful exposure range of D-502 (see Co^{60} curves for D-502 and for D-606 in Figure 3). As a consequence, the stack-characteristic curve at high energies (see Figure 4, Co^{60} stack curve) resembles that of D-502. Intermediate energies should exhibit an intermediate behavior. The two curves of

[3] For a given set of processing conditions, the shape of a film's characteristic curve is very nearly the same for all x-ray energies, and a mere linear transformation of the exposure axis converts a curve obtained at one radiation energy into that obtained at another.

stack response as a function of photon energy, plotted in Figure 1 for densities 0.5 and 3, and the stack-characteristic curves of Figure 4 indicate that, as long as one restricts oneself to densities below 3, the change in shape of the stack-characteristic curve with radiation energy does not cause a prohibitive inaccuracy in dose interpretation.

CALIBRATION OF FILM-STACK DOSIMETER

Accuracy and Useful Range: The stack response curves of Figure 1 suggest selecting an average energy of 120 kev for calibration purposes, as the stack dosimeter response at this energy lies roughly between the maximum and minimum response for the other energies. Table II shows the approximate accuracies with which exposure can be interpreted in terms of stack density for the various density levels, when 120-kev x-radiation is used for the calibration. The accuracy is seen to be within ±20 per cent below 3 r and between ±20 and ±30 per cent for exposures between 3 and 6 r. A detailed calibration of the lower limit of the dosimeter's useful range was not carried out, but this limit seems to lie at about 250 mr. A slightly shorter developing time could probably depress it to 100 mr or less.

TABLE II: ACCURACY OF STACK-FILM DOSIMETER FOR EXPOSURES TO X-RADIATION IN THE ENERGY RANGE FROM ABOUT 30 KEV TO BEYOND 1 MEV

Photographic Density	Dose Interpretation* (r)	Per cent Accuracy
0.5	0.32 ± 0.06	19
1.0	1.3 ± 0.2	15
2.0	3.4 ± 0.7	21
3.0	6.2 ± 1.8	29

* Based on calibration with narrow spectral band of continuous x-rays, average energy 120 kev, and development in liquid x-ray developer for five minutes at 20° C.

For reasonable accuracies, no stack dosimetry above density 3 (corresponding to an exposure of about 6 r under the present processing conditions) should be attempted. For emergency work with known radiation energies, however, the use of the dosimeter can be modified by merely determining the densities of the D-606 films alone (either "front" and "back" films stacked, or separate) and by interpreting them on suitable calibration curves. It is thus possible to obtain indications of million-volt x-ray exposures up to roughly 300 r (for the two D-606 films stacked) or 600 r (for the single D-606 film facing the radiation source). An extension to higher radiation energies—say up to the energies of the radiation from a 10-MV betatron—should not produce an additional inaccuracy of more than 10 or 15 per cent.

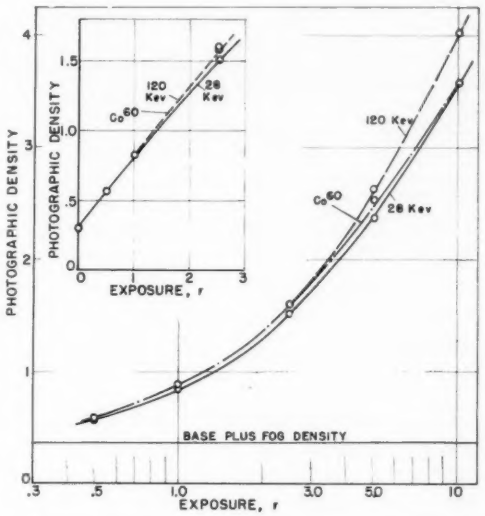

Fig. 4. The stack-film dosimeter: sample characteristic curves; films developed in liquid x-ray developer for five minutes at 20° C.

SUMMARY

A photographic personnel dosimeter has been developed whose main feature is its usefulness over the photon energy range from about 30 kev to beyond 1 MEV. It may be employed to interpret x-ray exposures from 250 mr to 3 r with an accuracy of ±20 per cent, and exposures from 3 r to 6 r with an accuracy of ±30 per cent. No knowledge of photon energy is required. If the photon energy is known to be in the million-volt region, the range of the dosimeter can be extended to 600 r.

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SUMMARIO IN INTERLINGUA

Dosimetro Photographic, al Uso del Personal, pro Roentgenoradiation de Inter 30 kev e Plus Que 1 MEV

Ha essite disveloppate un dosimetro photographic al uso del personal que es utile con energias photonic ab circa 30 kev usque a plus que 1 MEV. Illo es cognoscite como "dosimetro a pila de pelliculas" e utilisa duo typos de pellicula in paccos conventional de pellicula dental. Le paccos es placiate in porta-pelliculas combinate de plastico e de metallo, e tanto le pelliculas como le portatores es seligite de maniera que le responsa del pellicula non-sensibile (que es placiate in le portion plastic del portator) al impacto de radiation a basse energia es approximativemente equal al responsa del pellicula sensibile (que es placiate in le portion metallic del portator) al impacto de radiation a alte energia. Omne le pelliculas exponite in le mesme portator es colligite in un pila post lor disveloppamento, e lor densitate summari es determinate e ponite in relation al exposition radiational.

Le dosimetro a pila de pelliculas pote esser usate pro mesurar expositiones a radios X ab 150 milliroentgens usque a 3 roentgens con un margine de precision de ±20 pro cento e expositiones a radios X ab 3 roentgens usque a 6 roentgens con un margine de precision de ±30 pro cento. Il non es necessari que le energia photonic es cognoscite. Si il es cognoscite que le energia photonic pertine al ordine de 1 MEV, le limite del dosimetro pote esser extendite a 600 r.

Relation of Tumor Size to Radioresistance[1]

CHARLES M. NICE, JR., M.D., M.S., Ph.D.

With the technical assistance of

JOHN KUNTZ, B.S.

IN PREVIOUS experiments on the development and transplantation of locally radioresistant mouse lymphoma, the larger tumors, previously treated or untreated, appeared to be the more resistant to the effects of local irradiation. This phenomenon was observed in two lines of lymphoma cells in two strains of mice and seem to agree with Sturgis' clinical observation (9) that in leukemia in man acquired radioresistance is related to progression of the disease. It has also been observed in human subjects with Hodgkin's disease that relatively large tumors require larger doses of irradiation for local eradication (7). To test whether this observation is statistically significant, it was decided to treat groups of mice with tumors of various sizes (0.8 to 2.2 cm. in diameter) with single doses of 200 to 1,000 r.

METHOD

For these experiments, the Gardner line of lymphosarcoma was transplanted subcutaneously into the right flank of CBA mice. This tumor has been found to grow equally well in the parent C_3H mice in which it arose and in the CBA strain (4).

For transplanting, the tumor tissue was dissected out immediately after the animal had been sacrificed by fracturing the cervical spine. The tumor cells were suspended in sterile 0.85 per cent sodium chloride solution, a random cell count being 32,000 cells per cubic milliliter. Usually 0.02 to 0.04 ml. produced a visible wheal in the mouse flank, and this was considered a satisfactory transplant.

For local irradiation, the untreated portion of the mouse was shielded with 2.0 mm. of lead, which absorbs over 98 per cent of the radiation employed. Technical factors were: 140 kvp, 30 cm. target-skin distance, 15 ma, and 2.0 mm. Al filter (h.v.l. 4.2 mm. Al). With these factors, slightly over 21 r in air are delivered to the surface of the skin for each minute of irradiation.

The tests were carried out in a large number of transplant generations extending over a period of two years. In the earlier generations the tumor was less virulent; it grew locally to a large size, but at autopsy the majority of the mice revealed no evidence of dissemination. The tumors in these animals often grew to 3 or 4 cm. in diameter. In later transplant generations, metastasis occurred much more frequently, often before the tumor attained a diameter of 2.0 cm.

This increasing virulence with serial transplantation was also detected in the response to irradiation, in that the tumors of 1.0 cm. in diameter, or smaller, were more resistant to small doses of local irradiation in the 200 to 400 r range.

RESULTS

In measuring the response to irradiation, the end-point selected was survival of the host with no evidence of tumor two months after irradiation. These mice were considered cured.

About midway in the course of the experiment the data were collected and a curve was drawn to illustrate the 50 per cent host-survival-with-tumor-cured level. This curve (see Figure 1) shows that, with increasing sizes of Gardner lymphosarcoma in CBA mice, increasing doses of

[1] From the Department of Radiology, University of Minnesota Medical School, Minneapolis, Minn. Research supported by an institutional grant from the American Cancer Society.

This material is an abridgement of part of a thesis submitted to the University of Minnesota Graduate School in partial fulfillment of the requirements for the Philosophy Degree in Radiology. Accepted for publication in August 1956.

TABLE I: PERCENTAGE OF TUMOR ERADICATION FOR TUMORS OF VARIOUS SIZES RECEIVING VARIOUS DOSES OF IRRADIATION.

(The numerator indicates the number of mice surviving two months without evidence of tumor; the denominator indicates the number of mice treated)

Tumor Diameter	200–400 r		450–800 r		1,000–1,500 r	
0.8–1.0 cm.	57/172	(32%)	38/60	(64%)	8/16	(50%)
1.2–1.4 cm.	41/177	(23%)	62/132	(47%)	1/11	(9%)
1.6–2.2 cm.	2/16	(13%)	14/72	(19%)	2/11	(18%)

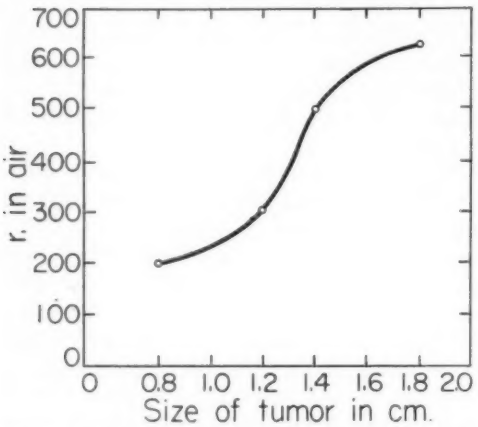

Fig. 1. Curve illustrating dose of irradiation necessary to eradicate 50 per cent of tumors.

radiation are required to cure 50 per cent of the hosts of all evidence of tumor. Indeed, in mice with tumors over 1.8 cm. in diameter, it was impossible to eradicate this percentage of tumors.

The number of mice from which the data shown in Figure 1 were derived was considered inadequate for statistical analysis. Therefore, the tests were extended over a greater number of transplant generations.

When finally assessed, the tests included 657 mice of sixty transplant generations over a period of two years. These data have been assembled in Table I and Figure 2. It will be noted that there is a definite tendency for larger previously untreated tumors to be more resistant to irradiation than smaller previously untreated tumors. The group of mice with tumors 1.6–2.2 cm. in diameter which received doses of 200 to 400 r is small not only because it was obvious very early that fewer tumors would be eradicated, but also because these tumors often were scarcely affected by the small doses. The groups of mice which received 1,000 to 1,500 r are small because even local irradiation over the flank and abdomen apparently kills many of the animals though the tumor is eradicated. These large doses seldom destroy the large tumors. Doses below 200 r failed to affect even the smaller growths.

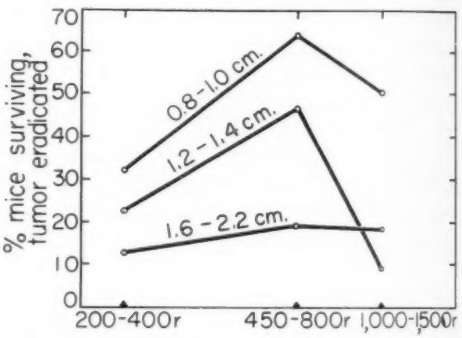

Fig. 2. Curves demonstrating the percentage of tumors eradicated when tumors of various sizes are treated with various doses of irradiation.

The most significant differences in the data depicted in Table I and Figure 2 are in the figures denoting the response of tumors of increasing size to the intermediate dose range of 450 to 800 r. In this dose range, the following host-survival-with-tumor-eradicated data are observed:

(*a*) 0.8–1.0 cm. diameter . . 38/60(64%)
(*b*) 1.2–1.4 cm. diameter . . . 62/132(47%)
(*c*) 1.6–2.2 cm. diameter . . . 14/72(19%)

The Chi-square test was applied to these data by J. E. Bearman of the Department of Biostatistics of the University of Minnesota. Comparing *a* and *b* yields $X^2 = 4.49$, $P = 0.036$. Comparing *b* and *c* yields $X^2 = 15.05$, $P = 0.001$. These figures are quite significant,

especially the latter, which indicates that there is one chance in a thousand that these observations could happen by chance.

DISCUSSION

These experimental observations are in accord with stated clinical observations on human subjects with leukemic and other lymphomatous masses (7) treated by irradiation and may be of importance in planning clinical radiotherapy. In treating previously untreated patients with Hodgkin's disease, it is noted that relatively large masses may respond rather slowly to local irradiation, and that relatively larger doses are required to eradicate the larger local masses.

Again referring to Table I and Figure 2, it is interesting to note that in the mouse tumors measuring from 0.8 to 1.4 cm. increasing the dose from the 200 to 400 r range to the 450 to 800 r range doubles the percentage of tumors eradicated. This may lend credence to the idea of giving the maximum safe dosage in the clinical radiotherapy of apparently localized lymphomatous masses (1–3, 5–7, 8, 10).

To speculate further, if previously untreated tumors are increasingly resistant to irradiation with increasing size, then previously treated tumors might exhibit an increasing resistance to irradiation with progression of the disease. Thus, increase in the size of the tumor or progression of the disease could be one of the factors operating in acquired resistance to irradiation.

SUMMARY AND CONCLUSIONS

With increasing size, Gardner lymphosarcoma in previously untreated CBA mice demonstrates increasing degrees of resistance to local roentgen irradiation.

This observation might be interpreted in such a manner as to favor the intensive radiotherapy of apparently localized lymphomatous masses.

Increase in tumor size or progression of disease may be one of the factors operating in acquired resistance to irradiation.

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SUMMARIO IN INTERLINGUA

Relation Inter le Magnitude de Tumores e lor Radioresistentia

Esseva executate experimentos pro determinar le existentia possibile de relationes inter le magnitude de tumores e lor responsa al radiation. Le tumor usate esseva le lymphosarcoma de Gardner que esseva transplantate, durante un periodo de duo annos, in successive generationes de previemente non tractate muses.

Le puncto terminal seligite pro determinar le responsa al irradiation esseva superviventia sin evidentia tumoral duo menses post le tractamento. Secundo iste criterio il esseva monstrate que pro curar 50 pro cento del hospites, augmentate doses de irradiation es requirite quando le magnitude del tumores es augmentate. Super le base de iste observationes, le opinion es exprimite que augmento del magnitude del tumor o progresso del morbo es possibilemente inter le factores responsabile pro le acquirimento de radioresistentia.

Dysplasia Epiphysialis Hemimelica

(Tarso-epiphyseal Aclasis)[1]

THEODORE E. KEATS, M.D.

DYSPLASIA EPIPHYSIALIS hemimelica is a rare epiphyseal dysplasia of the extremities which is readily recognizable roentgenographically. It is the purpose of this communication to review the clinical and roentgen features of this disorder and to add a new case to the literature.

This condition was originally reported by Mouchet and Belot in 1926 (1), but was first recognized and described as a definite entity in 1950 by Trevor (2), who collected 10 cases, to which he gave the name tarso-epiphyseal aclasis. Single cases have been published since that time by Ingelrans and Lacheretz (3), Donaldson *et al.* (4), and D'Angio *et al.* (5), and in 1956 Fairbank reported 14 additional examples, including 2 involving the upper extremity, which appear to fall into this group (6). Prior to the latter report, it was believed that this anomaly was confined to the lower limbs. Both D'Angio *et al.* and Fairbank have presented excellent reviews of this subject. The present paper will embody their data and a survey of the entire 29 cases now recorded.

NOMENCLATURE AND NATURE OF THE LESION

Fairbank considered the name tarso-epiphyseal aclasis open to two objections. First, although the tarsus is a common site of involvement, it is not invariably affected. Second, there is not simple failure of the perichondrium to model the epiphysis (aclasis), but rather a true dysplasia of the epiphysis itself. The condition is in general confined to the lateral or medial half of the single limb. For these reasons, the name "dysplasia epiphysialis hemimelica" (*hemi* + *μελος*, limb) has been suggested, and this choice appears to be warranted.

The disease is an abnormality of the epiphysis which may affect any of the osseous structures of the lower limb, and presumably of the upper as well. There is an eccentric cartilaginous overgrowth with resulting asymmetrical enlargement of the involved ossification center. As mentioned previously, an apparent characteristic of the lesion is restriction of the overgrowth to one-half of the affected epiphysis of the long bone; when more than one epiphysis is involved, all the epiphyseal centers affected show overgrowth of either the medial or lateral portions.

CASE REPORT

D. T., a 3-year-old white girl, was admitted to the University of Missouri Hospital on Nov. 27, 1945, with a history of growing tumors of the left knee and ankle, present since early life. Previous medical history included only the usual childhood diseases. Physical examination showed a healthy child with large masses on the left knee and ankle, arising from the medial aspect of each joint, causing 45 degrees of valgus deformity.

Roentgen examination showed marked overgrowth of the medial aspects of the distal femoral and tibial epiphyses, producing the above described deformities. There were multiple scattered foci of ossification and calcification within the enlarged ossification centers, extending well beyond the usual limits of these structures. The medial aspect of the talus was deformed and irregular (Fig. 1). Examination of the chest, pelvis, hips, upper extremities, and right leg disclosed no evidence of abnormality.

On Dec. 5, the left knee was explored. One portion of the tumor was found to be free and was removed. Enough of the mass was excised from the femur to permit normal relationships of the knee joint. Histologic examination of the excised tissue showed osteochondromatous material.

The postoperative course was complicated by slippage of the distal femoral epiphysis posteriorly, with development of a subperiosteal hematoma around the distal shaft of the femur. In addition, premature closure of the distal femoral epiphysis was noted. This complication necessitated a supracondylar osteotomy in November 1946 for correction

[1] From the Department of Radiology, University of Missouri School of Medicine, Columbia, Mo. Accepted for publication in October 1956.

Fig. 1. Roentgenograms of the left knee and ankle at the age of three years, showing marked overgrowth and irregular ossification of the medial aspects of the distal femoral and tibial epiphyses, resulting in valgus deformities of the joints. The proximal tibial metaphysis is widened and curved.

of the deformity. Roentgen examination at this time showed that the multiple irregular foci of calcification had fused with the main body of the epiphysis, resulting in marked enlargement of the medial aspects of the involved epiphyses. (Fig. 2).

In 1948, the patient was readmitted for removal of the prominent medial malleolus and a wedge osteotomy of the tibia for correction of the valgus position of the heel.

Roentgenograms of the left foot made in August

Fig. 2. Roentgenograms of the left leg at the age of four years, showing union of the multiple foci of ossification with the main body of the epiphysis.

1949 again showed involvement of the left talus and, in addition, evidence of involvement of the navicular, first cuneiform, and the first metatarsal. The navicular and first cuneiform were irregular, with extraosseous foci of ossification. The first metatarsal was relatively elongated (Fig. 3).

Persistent deformity of the ankle required revision osteotomy of the tibia above the joint in November 1955. Since that time, the patient has done well.

DISTRIBUTION

The locations of the affected ossification centers in the collected cases are listed in Table I. In no case was more than one limb affected. Fairbank points out that in Trevor's reported case of bilateral involvement, the lesion of the right foot represented an aseptic necrosis, with no changes of dysplasia epiphysialis hemimelica.

The talus and the distal ends of the femur and tibia are the most common sites of involvement, in that order. The patients show no evidence of consistent associated abnormalities, and there is no evidence of a familial or hereditary influence. The condition occurs more commonly in males.

CLINICAL MANIFESTATIONS

The mechanical difficulties resulting from the overgrowth of the affected ossification centers are the only cause of clinical signs and symptoms. The usual complaint is that of an increasing swelling on one side of the knee or ankle in an otherwise healthy child. The limb deformities produced by the asymmetric epiphysis may direct the parents' attention to the involved limb. The length of the extremity is usually unaffected, but this is not always the case.

Fig. 3. Roentgenograms of the left foot at the age of five years, eight months. There is irregularity of the talus, navicular, and first cuneiform, as well as relative overgrowth of the first metatarsal.

ROENTGEN FINDINGS

The epiphyseal abnormalities are confined to one side of the affected limb. The epiphysis may show irregular enlargement of the involved side or there may be many irregular centers of ossification separate from the main epiphysis and so closely packed together that they simulate a single mass of bone. As the child grows older, these separate centers of ossification

TABLE I: DISTRIBUTION OF LESIONS IN 29 CASES OF DYSPLASIA EPIPHYSIALIS HEMIMELICA

Case	Lower Extremity											Upper Extremity				
	Prox. Femur	Lesser Trochanter	Distal Femur	Prox. Tibia	Distal Tibia	Distal Fibula	Talus	Navicular	First Cuneiform	First Metatarsal	Phalanges	Lunate	Multangulars	Navicular	First Metacarpal	Distal Ulna
Mouchet and Belot							X									
Donaldson *et al.*			X													
Inglerans and Lacheretz		X	X	X	X		X	X	X							
Trevor 1						X	X									
2			X													
3			X			?X	X									
4			X	X	X		X									
5			X	X	X											
6			X	X		X	X									
7	X		X		X		X	X	X							
8	X	?X	X		X		X	X	X							
9					X		X	X								
10			X						X							
Fairbank 1			X	X					X							
2						X	X									
3	X		X	X		X	X									
4					X		X									
5						X	X									
6			X													
7			X			X	X	?X								
8							X									
9			X	X	X		X	X	X							
10					X		X	X	X							
11			X		X				X							
12					X		X									
13													X	X	X	
14												X				X
D'Angio *et al.*			X	X	X		X	X	X	X	X					
Keats			X		X		X	X	X	X						
TOTAL	3	2	18	8	13	7	20	9	10	2	1	1	1	1	1	1

tend to fuse with each other and then with the main epiphysis, as demonstrated by the case presented here. The bony enlargement may extend anteriorly or posteriorly; if there is impingement on the opposing articular surface, varus or valgus deformity results. Secondary deformity of the opposing epiphysis may occur. If the bony projection is unusually long, a portion or all of it may become broken off and the fragment remain permanently separated from the main epiphysis.

Several of the cases, including that recorded above, showed widening of the metaphyseal region of the affected bone. This does not appear, however, to represent a failure of tubulation.

Involvement of the tarsal and carpal bones is manifested in some cases by premature appearance, irregularity of outline, and excessive size. Slight increase in length of the medial metatarsals and metarcarpals may occur.

DIFFERENTIAL DIAGNOSIS

The diagnosis of this condition involves, for the most part, differentiation of the three known conditions in which the primary defect lies in the epiphysis, namely, dysplasia epiphysialis multiplex, dysplasia epiphysialis punctata (chondrodystrophia calcificans congenita), and dysplasia epiphysialis hemimelica. The epiphyses may be involved in other diseases, but usually only as a part of a general osseous involvement.

In *dysplasia epiphysialis punctata* there is abnormal development of the ossification centers throughout the body. These centers may appear prematurely, may be enlarged, and show scattered foci of ossification, but do not manifest the asymmetric involvement of dysplasia epiphysialis hemimelica, nor are they confined to a single extremity. In addition, there are in dysplasia epiphysialis punctata many associated abnormalities, including dwarfism, flexion contractures, mental deficiency, and cataracts.

In *dysplasia epiphysialis multiplex* as well, the ossification centers may be enlarged and show scattered, irregular foci, but the epiphyses throughout the body are affected, asymmetric involvement of the ossification center is not observed, nor are the changes limited to one limb, as in dysplasia epiphysialis hemimelica. In addition, patients with dysplasia epiphysialis multiplex are usually stunted in growth and show retarded skeletal maturation.

The ossification centers in *chondrodystrophy* (achondroplasia) may show spotty calcification, but there is no asymmetric overgrowth of the ossification centers. The tubular bones are short and may show broad, irregular metaphyses.

Cretinoid epiphyseal dysgenesis occurs in many hypothyroid infants, and is manifested by irregular, spotty ossification of the epiphyses, particularly those of the proximal femur and humerus. These centers, however, are not enlarged; they are symmetrical and are not confined to a single extremity. Cretins also exhibit retarded mental and physical development, and a characteristic facies.

Primary *aseptic necrosis* of a single ossification center may show irregular ossification and fragmentation of the affected center. However, the asymmetrical overgrowth and calcification seen in dysplasia epiphysialis hemimelica do not occur.

DISCUSSION

The etiology of dysplasia epiphysialis hemimelica is unknown. According to Fairbank, it is apparently a congenital error in development which for a short period of time, and in a minute area, affects either the pre-axial or post-axial part of the apical cap of a single limb bud. Histologically, there are apparently no characteristic features on which a specific diagnosis can be made from biopsy material. Microscopically, the appearances are indistinguishable from osteochondroma.

The similarity of roentgen and microscopic appearances of dysplasia epiphysialis hemimelica to the lesion described as epiphyseal osteochondroma (7) suggests

that these entities may actually be one and the same. In fact, the case reported here was so diagnosed before the true nature of the lesion was recognized.

Treatment is directed to correction of deformity and improvement of function. This may be attained surgically by excision of the cartilaginous mass, arthrodeses, and osteotomies. After complete or partial surgical removal, no attempt at regeneration of the excised portion of the epiphysis takes place. Apparently, the disease is self-limited by closure of the epiphysis with puberty. If possible, conservative measures should be utilized before that time. The importance of the early recognition of the nature of this condition in negating unnecessary and perhaps harmful surgical procedures is obvious.

SUMMARY

A case of dysplasia epiphysialis hemimelica is presented, with a review of its clinical and roentgen features. The disease is a self-limiting one which can be readily diagnosed roentgenographically by evidence of a dysplasia of one or more ossification centers in a single upper or lower extremity with localization of the sites of involvement to one side of the affected limb.

NOTE: The author expresses his appreciation to the Department of Orthopedic Surgery of the University of Missouri for the use of the clinical data used in this study.

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SUMMARIO IN INTERLINGUA

Dysplasia Epiphysee Hemimelic (Aclasis Tarso-Epiphysee)

Es presentate un caso de dysplasia epiphysee hemimelic, etiam cognoscite como aclasis tarso-epiphysee con un revista de su aspectos clinic e radiologic. Le morbo es auto-limitante e pote esser diagnosticate roentgenographicamente per demonstrar un dysplasia de un o plure centros de ossification in un sol extremitate superior o inferior con localisation del sitos del affection a solmente un latere del extremitate interessate. Le epiphyse pote exhibir un allargamento irregular del latere afficite, o il pote occurrer multe centros irregular de ossification separate ab le epiphyse principal e paccate si densemente que illos simula un sol massa de osso. In le curso del tempore iste separate centros de ossification tende a interfunder se le unes con le alteres e postea con le epiphyse principal. Le allargamento ossee pote extender se in direction anterior o posterior. Quando il occurre impingimento contra le opponite superficie articular, le resultato es un deformitate var o valge.

Calcification of the Myocardium

Case Report[1]

LaMAR I. HANKAMP, M.D.

THE FIRST CASE of calcification in a myocardial infarct was published by Simmonds in 1908. It was not until 1950, however, that a sizeable collection of cases was recorded. At that time Brean *et al.* presented a comprehensive article on the subject based on 14 patients. It was stated by these authors that not more than 20 undoubted cases of calcified myocardial infarcts had been published in the forty-two years following Simmonds' original paper. Since 1950, 4 additional cases have appeared in the English literature.

Although the calcified myocardial infarct may not be a rarity from the pathologic standpoint, it apparently is not demonstrated roentgenographically with sufficient frequency to allow for any considerable series from a single source. The following case is presented as an addition to the relatively few recorded in the literature. It has not been verified by autopsy, but we believe that the location of the calcification is so typical that such proof is not needed.

Mr. H. C., a 58-year-old Caucasian male, entered St. Joseph Mercy Hospital (Ann Arbor, Mich.) on Jan. 16, 1956, with a six-week history of shortness of breath, exacerbated by exertion, and an accompanying cough productive of thick white sputum. Five years previously he had been placed on digitalis and a salt-free diet for cardiac disease, but there was no recent history of edema, orthopnea, or chest pain. Review of the hospital record did not indicate any single event which would suggest a myocardial infarction. Recently a chest film had been obtained elsewhere and the possibility of pericardial calcification was raised. Pertinent points in the past history included a cholecystectomy in 1943, following an episode of jaundice, and a "severe aspirin allergy."

On physical examination the blood pressure was 140/88; pulse 78 and regular. Visual examination of the thorax revealed an increased anteroposterior diameter. The heart sounds were distant. No murmurs were present and the heart was not enlarged to percussion. The liver was palpable three to four fingerbreadths below the right costal margin, and a right inguinal hernia was noted.

Laboratory procedures included a complete blood count, Kahn test, urinalysis, and determination of CO_2-combining power. Except for a slight elevation of the white cell count to 12,000, the findings were normal. The electrocardiographic report was as follows: "PR, .16; QRS, .06; rate, 88; rhythm irregular, due to frequent premature ventricular contractions; prominent P waves in L2-3 AVF; absence of R waves in the precordial leads. Myocardial damage. Old anteroseptal and lateral left ventricular myocardial infarction. Correlate with clinical history. Auricular hypertrophy."

Postero-anterior, lateral, and oblique roentgenograms of the chest were obtained (Fig. 1) and the patient was also studied by means of fluoroscopy and spot-films (Fig. 2). A round fibro-calcific density, 1.0 cm. in diameter, at the periphery of the left mid-lung field anterior to the 6th interspace was seen in the lateral view. A linear fibrous scar was noted in the right apex. The lung fields showed a marked degree of emphysema, with bilateral flattening and depression of the diaphragm.

The cardiac silhouette and aorta were of normal size and configuration. The knob contained a slight amount of calcium. A curvilinear calcific deposit of considerable extent was seen related to the apex of the heart in the postero-anterior projection and far anterior in the lateral projection. It lay 1.0 cm. medial to the left cardiac border. Under fluoroscopic study the calcificied area moved synchronously with ventricular contractions; in the oblique projections the calcification appeared to be in the region of the interventricular septum.

The 7th, 9th and 12th intervertebral disks showed calcification. The disk spaces were of normal width and the appearance of the vertebral bodies was essentially normal.

Opinion: 1. Myocardial calcification following a myocardial infarction. 2. Healed fibro-calcific Ghon complex in left mid-lung field. 3. Advanced bilateral pulmonary emphysema. 4. Calcification of 7th, 9th and 12th thoracic intervertebral disks.

The course was uneventful and the patient was discharged on Jan. 25 with a diagnosis of primary pulmonary emphysema, Grade III, and anteroseptal and lateral myocardial infarct with calcification.

DISCUSSION

With a single exception, all the recorded cases of calcified myocardial infarcts,

[1] From St. Joseph Mercy Hospital, Ann Arbor, Mich. Accepted for publication in September 1956.

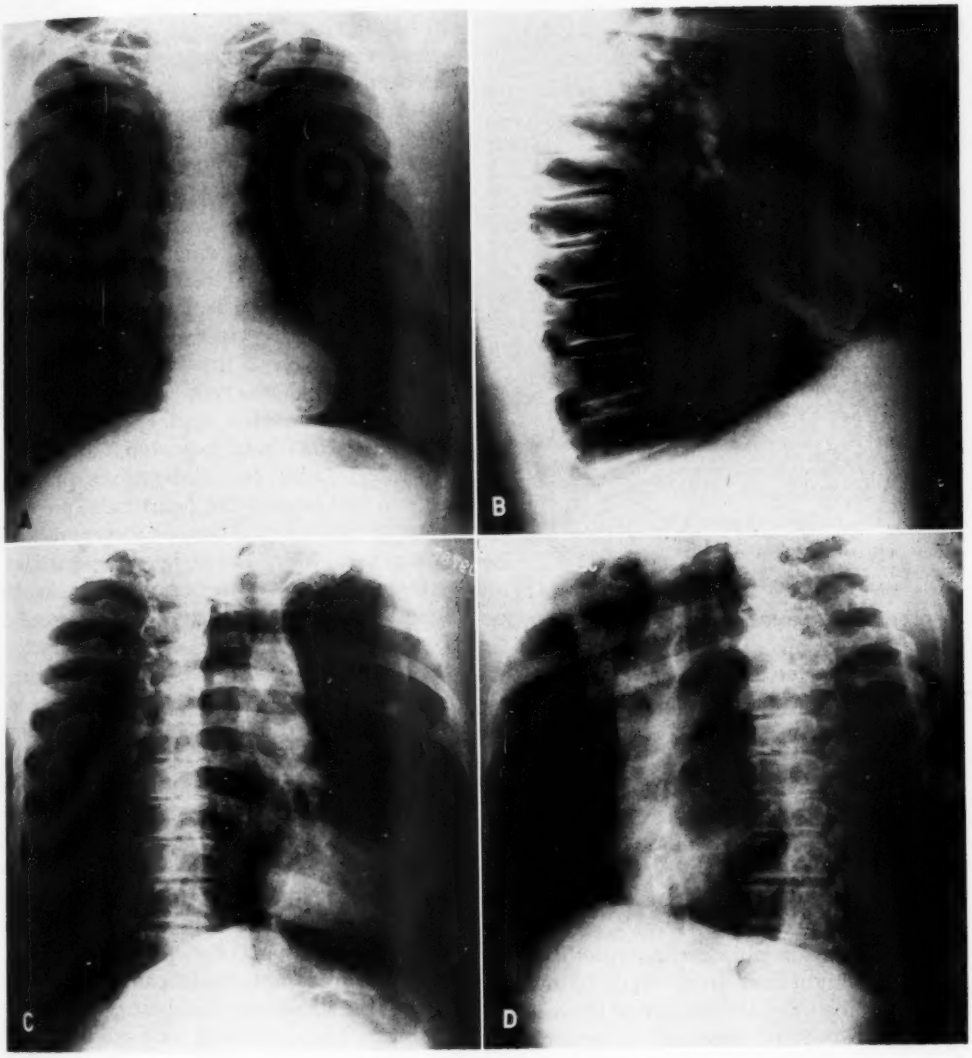

Fig. 1. A. Postero-anterior view of the chest, showing the position of the calcification relative to the left cardiac border.
B. Left lateral view. Note position of the calcification anteriorly.
C and D. Right anterior and left anterior oblique views, respectively.

including the present example, have occurred in males. The case reported here differs, however, from those of Brean in that roentgenologically the heart was of normal size and shape. All of Brean's patients for whom radiographs were obtained and all his autopsy cases showed cardiac enlargement.

Anderson, in his textbook of pathology, divides pathologic calcification into three main categories: (*a*) dystrophic calcification; (*b*) metastatic calcification, and (*c*) calcinosis. Calcification of the myocardium usually falls into the first classification. The *sine qua non* of all dystrophic calcification would appear to be the presence of necrotic or degenerative tissue. Diamond likewise, in reporting the case of

Fig. 2. Spot-film of the heart in right anterior oblique projection, showing finer detail of calcifi cation than the 6-foot film.

a premature infant (twenty-six weeks) who lived for thirty minutes and at autopsy showed extensive myocardial calcification, states that calcification follows degeneration or necrosis of muscle fibers due to vascular, inflammatory, or toxic conditions, and concludes that fatty degeneration plays no part. Other more common examples of this type of calcification include that seen in areas of tuberculous necrosis, in degenerating thyroid nodules, and in arteriosclerotic blood vessels.

Types of dystrophic cardiac calcification to be distinguished from that following infarction include calcification of the valves or mitral annulus, coronary artery calcification, calcification of the left atrial endocardium or mural thrombus calcification associated with mitral stenosis, and pericardial calcification. Myocardial calcification as a result of direct extension from a calcifying pericarditis can also occur, and a number of cases of endocardial calcification associated with a septal defect have been recorded. Rare causes of cardiac calcification include echinococcus cysts and calcified cardiac tumors. Several cases of myocardial calcification following a toxic or septic myocarditis have been published, and a case of myocardial calcification with subsequent ossification in a patient with severe sclerosis of the coronary arteries has been recorded.

Metastatic calcification, on the other hand, occurs in normal tissue, as a result of an overload of circulating calcium salts produced by extensive bone destructive processes within the body. Examples of cardiac calcification which have occurred in such pathological states include those due to myelogenous leukemia, hyperparathyroidism, hypervitaminosis D, osteomalacia, and renal insufficiency. A case of cardiac calcification associated with sarcoma of the dura and extensive bone destruction has been reported. It should be stated that, for a diagnosis of true calcium metastasis, the heart must present no evidence of necrosis or degeneration. Some cases which have been reported as metastatic gave evidence of necrosis of tissue and would therefore be correctly classified as dystrophic as well as metastatic.

Gore and Arons reported on 13 cases of calcification of the myocardium seen at the Army Institute of Pathology. In 12 of these cases azotemia was present. The 1 patient who did not show azotemia gave a definite history of hypervitaminosis D. The authors state that ordinarily the necrotic muscle fibers would be absorbed too rapidly to allow for calcification, but in these individuals the pathologic state which favored metastatic calcification enhanced the tendency to dystrophic calcification. They classify these cases as "accelerated dystrophic mineralization."

SUMMARY

A case of calcification of the myocardium following myocardial infarction has been reported. A brief discussion of the differential diagnosis and the pathological basis for cardiac calcification is presented.

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SUMMARIO IN INTERLINGUA

Calcification del Myocardio. Reporto de Un Caso

Relativemente pauc casos de calcificate infarcimentos myocardial ha apparite in le litteratura. Le autor reporta un caso in un masculo de 58 annos de etate. Le corde e le aorta se presentava in dimensiones e contorno normal. Un curvilinee deposito calcific de extension considerabile esseva vidite relationate al apice del corde in le vista postero-anterior e in sito anterior extreme in le projection lateral. Su loco esseva 1,0 cm medial ab le margine cardiac sinistre. Le observation fluoroscopic monstrava le area calcificate in motion synchrone con le contractiones ventricular. In le vistas oblique le calcification appareva in le region del septo interventricular. Esseva constatate calcification associate del septime, none, e decesecunde disco intervertebral.

Es recognoscite tres typos de calcification pathologic: (1) Dystrophic, (2) metastatic, e (3) de calcinosis. Le calcification del myocardio es usualmente del typo dystrophic.

Meconium Ileus[1]

RONALD E. HERSON, M.D.

MECONIUM ILEUS is a specific disorder occurring in the neonatal period, usually a manifestation of cystic fibrosis of the pancreas. Intestinal obstruction is caused by inspissation of thick, ropy, tenacious meconium, which is firmly adherent to the mucosa (2). The physical characteristics of this abnormal meconium are ascribed to absence of normal pancreatic enzymes. Obstruction usually occurs in the distal ileum but may be more proximal in the small intestine and may extend into the colon.

In the other types of neonatal intestinal obstruction caused by atresia, peritoneal bands, volvulus, and duplication of the intestinal tract, the intestinal contents orad to the site of occlusion are made up of normal meconium (2). Also, no associated pancreatic lesion is demonstrable.

Meconium ileus and meconium peritonitis have not always been clearly differentiated. Meconium peritonitis occurs whenever the fetal intestinal tube is defective or perforated and meconium escapes into the peritoneal cavity (1). Gangrene of the intestinal wall secondary to meconium ileus may lead to meconium peritonitis, but is only one of several possible causes.

The usual signs of meconium ileus include progressive distention of the abdomen, vomiting, and failure of the infant to pass meconium. One or all of these features may be present. Meconium ileus cannot be excluded because stools have been passed. Cystic fibrosis of the pancreas in older siblings greatly increases the likelihood of meconium ileus.

Palpation of the meconium mass determines with high probability the true nature of the ileus; a specific search should be made. In this series, one surgeon frequently was able to make an accurate diagnosis on the basis of this finding, despite the fact that in no case was the mass palpated by the admitting resident or physician.

Volvulus of the midgut is frequently associated with meconium ileus (3). This may or may not progress to strangulation, gangrene, perforation, and peritonitis.

Roentgen examination shows absence of gas in the bowel distal to the level of obstruction, with dilatation of proximal gas-filled loops. In addition, two signs originally believed to be specific for meconium ileus have been reported: Neuhauser (4) described the bubbly appearance produced by the mixture of swallowed air with meconium. It is now known that this finding is non-specific, having been demonstrated in other forms of obstruction (1, 5). White (5) has stated that in the presence of clinical symptoms, absence of fluid levels in dilated loops of obstructed small intestine warrants the radiographic diagnosis of uncomplicated meconium ileus. In 6 of his 10 cases fluid levels were absent or slight; the other 4 were complicated by volvulus, gangrene, or peritonitis.

MATERIAL AND METHODS

All cases of meconium ileus encountered at Babies Hospital (New York) from 1945 through 1955 and proved by surgery or necropsy were reviewed, a total of 18. All the patients had been explored surgically. One case was discarded because films made elsewhere were not available; 17 were analyzed. In 2 of these there was no erect view. For the purposes of analysis, the first roentgen examination only was used; these had all been performed prior to surgery.

A minimum of three films are obtained: a frontal view of the abdomen with the

[1] From the Department of Radiology, College of Physicans and Surgeons, Columbia University and the Presbyterian Hospital, New York, N. Y. Accepted for publication in October 1956.

TABLE 1: MECONIUM ILEUS IN SEVENTEEN WHITE INFANTS

Case No., Age (in days) and Sex	Signs	Roentgen Findings: Obstruction	Roentgen Findings: Fluid Levels	Roentgen Findings: Bubbles	Roentgen Findings: Peritoneal Fluid	Operative Findings: Meconium Ileus plus	Result
1. M 1	Vomiting, distention, meconium passed	+	+	+	0	360° volvulus of ileum; clear peritoneal fluid; band along transverse colon	Died in hospital
2. F 2	Distention, no meconium	+	Slight	++	0	No complications	Died in hospital
3. M 4 hr.	Slight distention, no meconium. Sibling with CFP*	0	0	0	0	Recent volvulus, 180°	Living with CFP 3 yr. 3 mo.
4. M 1	Vomiting, distention, no meconium	+	0	0	0	Partial volvulus	Died with CFP 3 yr. 10 mo.
5. M 1	Vomiting, no meconium	+	+	0	+	Volvulus of ileum; no gangrene	Died with CFP 2 yr.
6. F 2	Vomiting, no meconium	+	Slight	Slight	0	No complications	Died in hospital
7. M 1	Vomiting, distention, no meconium	+	Slight	++	0	No complications	Died at 2 mo., of respiratory infection
8. M 1	Distention, no meconium. Sibling with CFP	+	0	Slight	0	Volvulus, 520°; gangrene	Died in hospital
9. F 1	Distention, no meconium	+	No erect film	+	0	No complications	Died in hospital
10. M 2	Vomiting, distention, no meconium	+	+	++	0	No complications	Living with CFP 7 yr.
11. M 1	Vomiting, distention, no meconium	+	0	Slight	0	No complications	Died in hospital
12. F 2	Vomiting, distention, no meconium	+	1 (volvulus)	0	0	360° Volvulus of ileum; no gangrene	Living 7 mo. without CFP
13. F 7	Vomiting, distention, meconium passed	+	No erect film	+	0	No complications	Died in hospital
14. M 2	Vomiting, meconium passed	+	Slight	++	+	360° volvulus without gangrene or peritonitis	Died in hospital
15. F 1	No meconium (premature 1,025 gm.)	+	0	0	0	Moderate amount of peritoneal fluid	Died in hospital
16. M 2	Vomiting, no meconium	+	1	++	0	360° volvulus of midgut	Died in hospital
17. M 3	Vomiting, meconium passed	+	+	+	0	No complications	Died in hospital

*CFP. Cystic fibrosis of the pancreas.

child supine, and frontal and lateral erect views. In some instances lateral decubitus projections were also made, with a horizontal beam, but little additional information was obtained from them.

The patients were all of the white race.

DISCUSSION

Relevant data are listed in the accompanying table.

Evidence of distal small bowel obstruction was present in all but 1 case, in which examinations were performed at four and eight hours after birth. Gas progresses rapidly through the normal neonatal intestinal tract, so that the colon is usually demonstrable at twelve hours. Individual variations, however, make the roentgen diagnosis of obstruction hazardous before twenty-four hours, unless failure of progression of the air can be shown on serial studies.

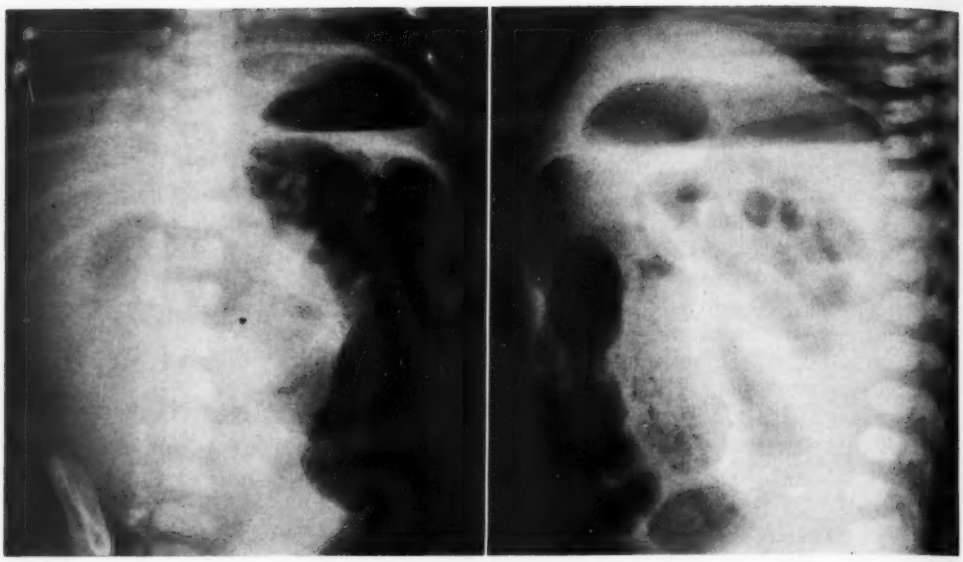

Fig. 1. Case 2. Uncomplicated meconium ileus. Erect frontal and lateral views of the abdomen show evidence of obstruction in the distal small intestine. Several small fluid levels are present, as is a distended segment containing admixed gas and meconium.

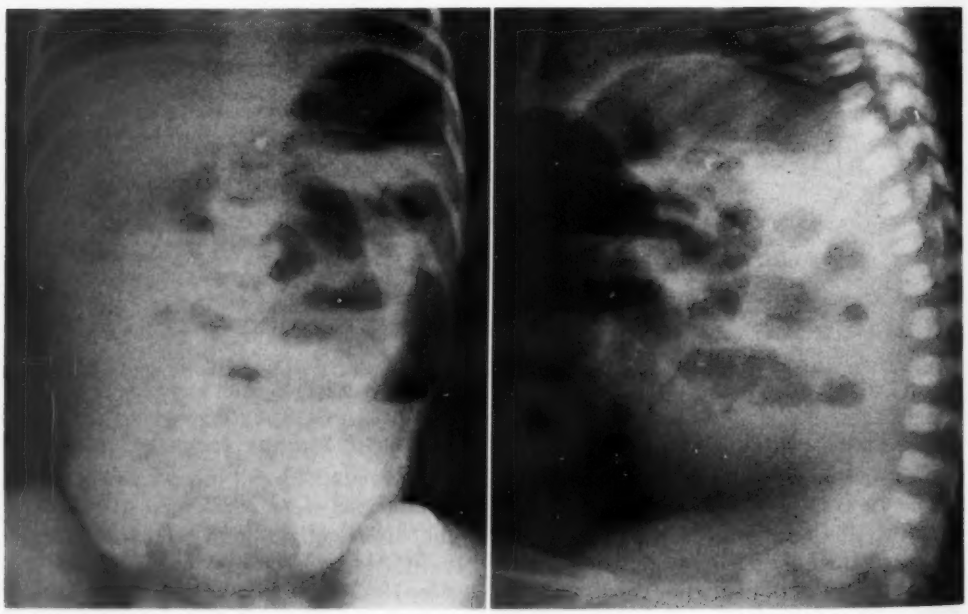

Fig. 2. Case 17. Uncomplicated meconium ileus with findings similar to those in Fig. 1. The fluid levels are more pronounced.

The roentgen demonstration of abdominal calcification is good evidence of complicating peritonitis.

Air bubbles, as described by Neuhauser, were shown in 12 of the 17 patients. Although non-specific, this sign is felt to be valuable. When marked, it can be correlated with clinical palpation of the meconium mass.

Fluid levels were observed in 10 of the 15 cases. They were absent in 3 of the 8 complicated cases, slight in 3, and obvious in 2. In the 7 uncomplicated cases, they were absent in 2, slight in 3 (Fig. 1), and obvious in 2 (Fig. 2). Thus, absence of fluid levels did not aid in the diagnosis of meconium obstruction or in the differentiation of complicated and uncomplicated cases. Meconium ileus is manifest clinically soon after birth, and is almost always accompanied by vomiting. The presence or absence of fluid levels may depend upon whether or not the infant is taking and tolerating fluids by mouth.

SUMMARY

A series of 17 proved cases of meconium ileus has been analyzed. In 16 of these there was roentgen evidence of small bowel obstruction. Air bubbles were demonstrated in 12 patients, and, though not specific, are considered of diagnostic value in conjunction with a palpable meconium mass. The absence of fluid levels was not found to be a reliable sign of meconium ileus.

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SUMMARIO IN INTERLINGUA

Ileo a Meconio

Le examine roentgenologic de ileo a meconio revela le absentia de gas in le intestino distal al nivello del obstruction e dilatation de ansas plenate de gas proximal al obstruction. Il pote occurrer un apparentia "bullose" que resulta del mixtion de aere ingerite con le meconio, sed iste constatation non es specific. On ha signalate que in casos non-complicate le absentia de nivellos de fluido es un constatation significative, sed isto non es corroborate per le observationes del autor.

Un serie de 17 casos es analysate. Evidentia roentgenologic de obstruction distal del intestino tenue esseva trovate in omnes, excepte un. Bullas de aere esseva demonstrate in 12 patientes. Le presentia de illos esseva considerate como de valor diagnostic in conjunction con palpation del massa de meconio.

Comparative Roentgen Findings in Symptomatic and Asymptomatic Backs[1]

TOM M. FULLENLOVE, M.D.,[2] and A. JUSTIN WILLIAMS, M.D.[3]

NOT LONG AGO a large industrial company (1) decided to survey a group of men who had been in its employ for ten years or more, who denied having discomfort in the back either on or off the job, and who had not asked for treatment for back disability at any time during their employment. Chosen for this survey were 200 men in the outside equipment and construction forces, including some drivers and supplymen, who had worked in these forces exclusively for not less than ten years. The average age of the group was forty years, and the average length of service was eighteen years.

Anteroposterior and lateral films of the entire lumbar spine and a spot film of the fifth lumbar vertebral area were made. All abnormalities were reported in the following classifications: congenital, traumatic, degenerative, inflammatory, arthritic, neoplastic, and structural.

For purposes of comparison, 200 consecutive patients referred for myelography were studied. The average age was thirty-eight years. All of these patients had low back and/or leg pain. Of this last group of 200 patients, 68 were operated on for herniated nucleus pulposus (2). All of the findings are noted in Table I.

TABLE I: ROENTGEN FINDINGS IN 200 PERSONS WITH AND 200 WITHOUT SYMPTOMS REFERABLE TO THE BACK

	200 Asymptomatic Cases	200 Symptomatic Cases	68 Symptomatic Cases Treated Surgically
CONGENITAL			
Spondylolisthesis	5 (2.5%)	3 (1.5%)	1 (1.5%)
Spondyloschisis	3 (1.5%)	0	0
Ununited facet epiphysis	2 (1.0%)	0	0
Transitional vertebra	19 (9.5%)	27 (13.5%)	6 (8.8%)
Rudimentary disk	5 (2.5%)	6 (3.0%)	3 (4.4%)
Six lumbar vertebrae	14 (7.0%)	4 (2.0%)	2 (3.0%)
Spina bifida occulta	52 (26.0%)	6 (3.0%)	2 (3.0%)
TRAUMATIC			
Compression of body	1 (0.5%)	2 (1.0%)	1 (1.5%)
Transverse process	0	1 (0.5%)	0
DEGENERATIVE			
Narrow disk with spurs	18 (9.0%)	50 (25.0%)	22 (32.5%)
Narrow disks without spurs	62 (31.0%)	43 (21.5%)	18 (26.5%)
Osteoarthritic spur formation	68 (34.0%)	40 (20.0%)	12 (17.8%)
Settling and pseudospondylolisthesis	6 (3.0%)	3 (1.5%)	0
ARTHRITIC			
Degenerative	7 (3.5%)	18 (9.0%)	2 (3.0%)
Rheumatoid	2 (1.0%)	0	0
NEOPLASTIC			
Benign	1 (0.5%)	0	0
Malignant	0	1 (0.5%)	1 (1.5%)
STRUCTURAL			
Scoliosis	91 (45.5%)	60 (30.0%)	9 (13.2%)
Lordosis	5 (2.5%)	2 (1.0%)	1 (1.5%)
Flat	44 (22.0%)	44 (22.0%)	12 (17.8%)
Osteoporosis	5 (2.5%)	2 (1.0%)	0
Epiphysitis	4 (2.0%)	0	0
Schmorl's node	26 (13.0%)	11 (5.5%)	2 (3.0%)
Wedging	21 (10.5%)	0	0
Pelvic tilt	3 (1.5%)	4 (2.0%)	1 (1.5%)

[1] From the Department of Radiology, Franklin Hospital, San Francisco, Calif. Read before the Midsummer Conference of the Rocky Mountain Radiological Society, Denver, Colo., August 1956. Accepted for publication in October 1956.

[2] Assistant Clinical Professor of Radiology, University of California Medical School.
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Congenital lesions of the back (spondylolisthesis, etc.) were found to have essentially the same incidence in symptomatic and asymptomatic patients, and old traumatic lesions of the spine were also evenly distributed. Of the degenerative changes, narrowed disks with spurs showed a much higher incidence in patients having symptoms; there was no significant difference in the incidence of other degenerative lesions. Arthritis occurred in a definitely greater percentage of patients with symptoms than of those without. Malignant

TABLE II: INCIDENCE OF PATHOLOGIC CONDITIONS AND ANOMALIES REVEALED IN PRE-EMPLOYMENT X-RAY EXAMINATIONS OF 3,000 LUMBOSACRAL SPINES (FROM ALLEN AND LINDEM)

Condition	No. of Cases
DEGENERATIVE LESIONS	
Osteoarthritis	408 (13.6%)
Degenerated intervertebral disk	34 (1.13%)
POST-TRAUMATIC LESIONS	
Crush fracture of body	70 (2.33%)
Fractured transverse processes	19 (.63%)
CONGENITAL AND DEVELOPMENTAL LESIONS	
Spina bifida occulta	177 (5.9%)
Sacralization of transverse processes	151 (5.03%)
Spondylolisthesis	89 (2.96%)
Ununited ring epiphysis	42 (1.40%)
Lumbarization of transverse processes	17 (0.56%)
Scoliosis	15 (0.50%)
POST-SURGICAL LESIONS	
Spinal fusion	6 (0.20%)
Laminectomy	2 (0.06%)
MISCELLANEOUS CONDITIONS	
Soft-tissue lesions, questionable lesions of spine, etc.	21 (0.70%)

neoplasms are, naturally, a cause of back pain, but benign tumors are often discovered incidentally. Structural changes were found in equal number in the two groups. No cases of inflammatory disease or infection were found.

Many authors are in agreement that congenital abnormalities are a significant cause of low back pain (3–7). Dively and Oglevie (8) make the statement: "It is our feeling that back examinations should not be used simply as a means of evaluating the prospective employee. The adolescent should have a careful back examination, including x-rays, to determine any serious congenital architectural defects of the spine. If such defects are found, the individual can be advised to study a profession or trade in order that he may depend upon his brains and not his back for his livelihood." In their series of 6,523 pre-employment x-ray studies of the back the incidence of congenital anomalies was 41 per cent.

TABLE III: INCIDENCE OF CHANGES OBSERVED AT LUMBOSACRAL JUNCTION AS SHOWN BY ROENTGENOGRAMS OF 100 PERSONS WITH AND 100 PERSONS WITHOUT BACKACHE (FROM SPLITHOFF)

Type of Change	Normal	Backache
Transitional vertebra	10	10
Spondylolisthesis	3	2
Spina bifida occulta	6	4
Posterior displacement of L-5	14	16
Scoliosis or tilt, lumbar spine	9	16
Osteoarthritis	22	26

Bohart (9) and Splithoff (10) in studies similar to ours obtained comparable results. Bohart states that developmental anomalies did not prove a source of symptoms in a large series of men who were subjected frequently to severe trauma. Splithoff demonstrated that the findings on roentgenograms of the lumbosacral region of normal persons and of those with backache are quite similar; congenital anomalies and other anatomic details appear in close numerical sequence; degenerative changes are somewhat more frequent in patients with backache, and in these the sacral angle is slightly less. His findings are noted in Table III.

Allen and Lindem (11), whose findings are recorded in Table II, consider it "a moot question as to how great a role anomalies of the lumbosacral spine play in causation of back symptoms."

George and Leonard (12) in a study of the vertebrae in industrial accident cases expressed the opinion that congenital variations should be recognized and kept in mind, but should not lead one into giving an opinion that these changes are the cause of symptoms referable to injury, or independently a source of symptoms.

DISCUSSION

It is our feeling that congenital lesions as listed in Table I are not a source of

symptoms either in the presence of injury or apart from it, and that the present practice of attributing back symptoms to such a lesion is not valid. Old traumatic lesions and structural changes, as noted in Table I, may not give rise to symptoms, but the individual case must be considered.

As more of these comparative studies are reported, it becomes increasingly apparent that the bony changes may play no part in the cause of back symptoms. A great many backaches may be the result of soft-tissue changes which, of course, are not seen on the plain roentgenogram, such as strains and sprains, myositis and fasciitis, herniated nucleus pulposus, and radiculitis. Roentgenographically, the various bony findings are simply grouped by George and Leonard as follows:

1. The normal vertebra, including the many and varied anatomical variations.
2. Chronological, occupational, or postural changes, which include scoliosis and hypertrophic changes.
3. Changes due to remote and recent injury.
4. The chronic diseases, such as tuberculosis, arthritis, bone tumors, and syphilis.

CONCLUSION

A comparative study of 200 persons with and 200 without symptoms referable to the back is presented. All departures from normal were catalogued as congenital, traumatic, degenerative, arthritic, neoplastic, or structural. No inflammatory cases were encountered.

Congenital defects and structural changes are about equal in number in the two groups. It, therefore, seems doubtful that their presence *per se* is of clinical significance. We do not consider congenital defects or anatomical variations independently a cause of backache.

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SUMMARIO IN INTERLINGUA

Comparation del Constatationes Roentgenologic in Dorsos Symptomatic e Asymptomatic

Esseva executate un comparation del constatationes roentgenologic in duo gruppos de personas: (1) Duo centos empleatos de un compania industrial qui, durante un periodo de empleo de al minus dece annos, habeva nunquam experientiate dolores dorsal e (2) 200 patientes consecutive presentate con le requesta de examines myelographic a causa de dolores del dorso o del gambas. Le anormalitates observate esseva classificate como congenite, traumatic, degenerative, arthritic, neoplastic, e structural.

Un constatation significative esseva le incidentia equal de anormalitates congenite e structural in le gruppo symptomatic e le gruppo asymptomatic. Iste facto supporta le conclusion que le duo alterationes non pote esser considerate independentemente como causas de dolores dorsal.

Bilateral Osteochondritis of the Middle Cuneiform Bone

Case Report[1]

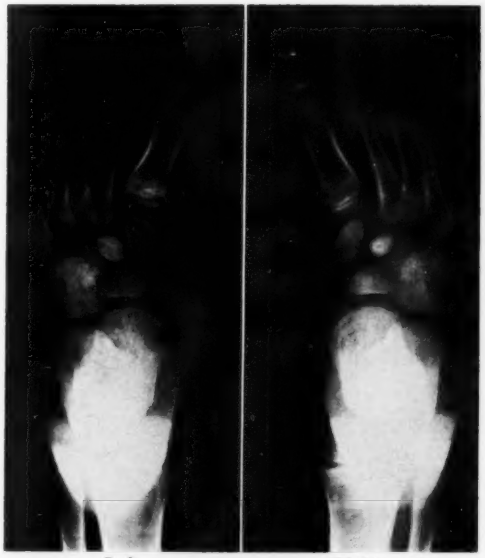
IVOR P. SMYTH, M.B., D.M.R.D.

OSTEOCHONDRITIS (focal aseptic necrosis) of various ossific centers has been described. The latter have been tabulated in some detail by Williams (1). Involvement of the middle cuneiform bone is apparently rare. A cursory review of the literature reveals only a single example (Hicks, 2), in the middle cuneiform of the left foot in a child of five. For this reason, it appears worthwhile to record the following case with bilateral involvement.

A well nourished white boy, five years of age, was referred to the Radiology Department with the following history. Six months previously, a heavy bench had fallen across his left foot producing some discoloration. Approximately one and a half months before bringing his son for examination, the father noticed that the child had a decided limp and favored the left foot. At that time, some swelling was observed over the dorsum of the left foot but there was never any complaint of pain in either foot. According to the father, the limp had increased somewhat up to the present time.

On physical examination, the right foot appeared normal. There was slight swelling but no tenderness over the distal tarsus of the left foot, as well as a pronounced left varus deformity and an abnormal gait. The remaining physical findings were normal.

Radiographs showed the right middle cuneiform to be irregular in outline, quite dense and smaller than normal. In addition, an abnormal trabecular pattern and fragmentation were demonstrated. The left middle cuneiform was also smaller than normal and abnormally dense. Its margins, however, were more regular and the fragmentation less pronounced. There was a linear metaphyseal fracture at the base of the left first metatarsal, possibly due to the trauma six months earlier.



Left Right

Fig. 1. Roentgenograms showing changes in both middle cuneiform bones.

NOTE: I am indebted to Mr. Tom Woodward for reproducing the radiographs.

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SUMMARIO IN INTERLINGUA

Osteochondritis Bilateral del Osso Mesocuneiforme
Reporto de Un caso

Un caso de osteochondritis del osso mesocuneiforme de ambe pedes esseva observate in un puero de cinque annos de etate. Roentgenogrammas revelava que le ossos afficite habeva dimensiones subnormal e esseva inusualmente dense. In le pede dextere il habeva un certe irregularitate in le contorno del osso, e fragmentation de illo esseva demonstrate. Le pede sinistre monstrava un simile tableau, sed le alterationes esseva minus pronunciate que in le dextere.

[1] From the Hospital of St. Raphael, New Haven, Conn. Accepted for publication in September 1956.

Duplication of the Clavicle

("Os Subclaviculare")[1]

CHARLES R. GOLTHAMER, M.D.

ANYONE HAVING the opportunity of studying larger series of chest radiographs invariably encounters variations or abnormalities in the development of the skeleton. These are usually incidental findings. Some, such as cervical ribs, fusions of vertebral bodies, and cleidocranial dysostosis, may be of clinical importance. Others are without clinical significance, as bifurcated ribs, rib anastomoses, os acromiale, os coracoideum, and appear to be of purely anatomical interest. They are sufficiently described in the roentgenologic and anatomical literature, although without any satisfactory explanation as to their origin.

Such reports of congenital anomalies of the clavicle as have been published deal with more or less extensive *defects*, ranging from small grooves to complete absence of the bone. No mention could be found in the literature of *duplication* of the clavicle. For this reason the following case is reported.

E. L., white male, aged thirty-four, suffering from deafness, bilateral cataract and bilateral atrophy of the peroneus muscles, following parotitis (final diagnosis, multiple sclerosis) was referred for x-ray examination of the chest. From the history it was learned that the patient had been aware of a small painless nodule just below the left clavicle as long as he could remember. This was found to be definitely palpable as a subcutaneous structure, freely movable with movements of the shoulder, particularly up and down. With firm pressure upon the skin, the subcutaneous mass could be moved upward toward the clavicle, indicating free motion, without attachment to the latter structure. On manipulation one had a definite sense of palpating the end of a freely movable osseous body, which laterally was located deep within the infraclavicular soft tissues. No pain, redness, or swelling was present. The overlying skin appeared elevated. No abnormality was noted on the right side.

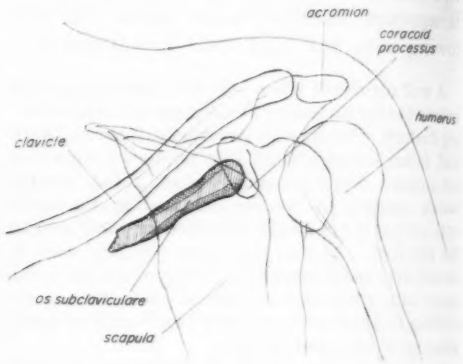

Fig. 1. Postero-anterior roentgenogram showing supernumerary bone below the normal clavicle.

A routine postero-anterior roentgenogram revealed a dense osseous body, approximately 7 × 1 cm., in the region of the left shoulder, just below the clavicle (Fig. 1), which it closely resembled. The lateral end of the bone was somewhat rounded and seemed to be attached to the coracoid process of the left scapula. The medial end was irregularly pointed and without any osseous connection with the bones of the immediate neighborhood (clavicle, sternum, or ribs). Anteroposterior and oblique views (Fig. 2) showed the location of this bone to be within the anterior soft tissues, about one finger's width below the clavicle. The medial free end appeared to be widened in an anteroposterior direction, thus being wedge-like in shape. A film taken with elevation

[1] Accepted for publication in October 1956.

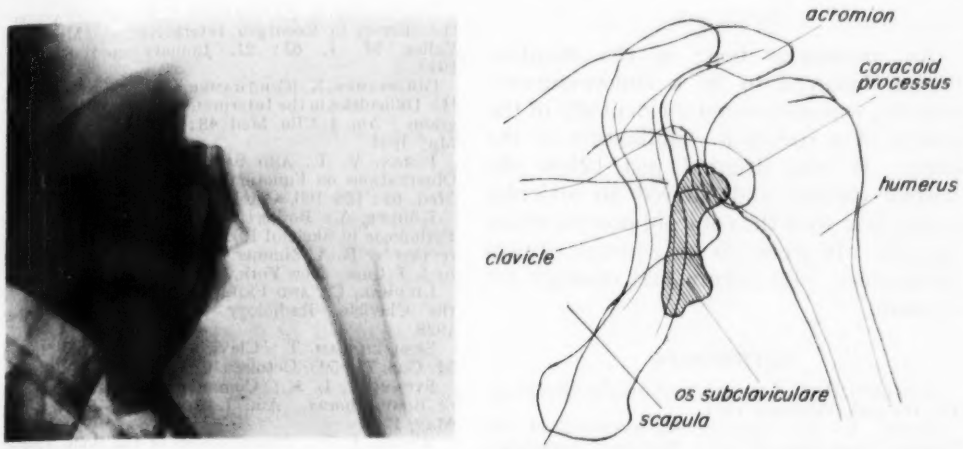

Fig. 2. Oblique view showing the location of the supernumerary bone to be within the anterior soft tissues below the clavicle.

of the shoulder girdle exhibited upward movement of the bone, without any change of the distance toward the clavicle. Angulation toward the scapula was definitely changed, however, suggesting articular connection with the coracoid process.

The location and the movement of this osseous body were confirmed under the fluoroscopic screen. Upon pressing at the lateral end no displacement could be achieved, suggesting fixation at the coracoid process. The medial end, however, could be easily displaced upward toward the clavicle by the examining finger.

No attempt was made to remove the structure for microscopic study, since there were no clinical indications justifying this procedure and since no solution of the developmental problem of this bone was expected. No other skeletal abnormalities could be found.

DISCUSSION

Other reports on congenital anomalies of the clavicle throw little light on the etiology of the case here described, since, as pointed out above, these have all concerned defects, in the sense of *insufficient development* of bony tissue as compared to the normal. We are dealing, on the other hand, with what appears to be a supernumerary partially developed clavicle, *i.e.*, an *overdevelopment* of bone.

Partial or complete absence of the clavicle might be explained by comparative anatomical studies. The function of the clavicle is to hold the arm away from the side of the chest and to fix the shoulder girdle. Mammals with lateral movement of the humerus or those having claws for holding objects, such as rodents, mice, and squirrels, develop a rudimentary clavicle without any attachments to the thorax or scapula. Man and monkey have fully developed clavicles because they have the greatest need for flexibility of shoulder motion.

A remotely possible explanation of the etiologic factors contributing to or responsible for the unusual anomaly presented above may be found in the peculiar development of the clavicle. The bone develops from a membranous connective-tissue rod, in which usually two calcification centers appear near the mid-point of the future bone, at the sixth week of intra-uterine life. Ossification proceeds from these two centers. In event of their failure to develop at all, a complete absence of the clavicle results. If the ossification centers do not fuse but grow separately, a defective clavicle or a clavicle consisting of two parts results. In our case the theory of displacement of one of the ossification centers *in utero*, producing a completely separate collarbone, suggests itself. Or it may be that more than two ossification centers were originally present and that one of these became displaced to form the supernumerary bone.

SUMMARY

An anomalous bone in the shoulder region, believed to be a supernumerary clavicle, was discovered incidentally in the course of a roentgen examination of the chest. It was situated just below the normal clavicle and showed an articular connection with the coracoid process of the scapula. It seems to be without clinical significance. Its nature and etiology are obscure.

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SUMMARIO IN INTERLINGUA

Duplication del Clavicula ("Osso Subclavicular")

Un osso anormal in le region spatular, interpretate como un clavicula supernumerari, esseva discoperite incidentalmente in le curso de un roentgeno-examine del thorace. Illo esseva situate justo infra le clavicula normal e monstrava nulle connexion articular con le processo coracoide del scapula. Illo es apparentemente sin signification clinic. Es opinate que illo es possibilemente le resultato del displaciamento de un del centros de ossification del clavicula in utero.

Immobilization of the Head During Rotational X-Ray Therapy[1]

HARRY L. BERMAN, Colonel, MC, USA

THE IMPORTANCE of maintaining a tumor in a fixed position during rotation therapy after accurate beam localization is well recognized. With tumors of the trunk this is ordinarily accomplished without difficulty, but with the equipment currently available for treatment of tumors of the head and neck, the problem is less simple. The usual rotation apparatus is provided with two flat wooden pieces to maintain the position of the head during treatment. These slats, sometimes reinforced with straps, are placed one on each side of the face. While these are suitable for keeping the head from swaying from side to side, they do not prevent its flexion on the chest. The disastrous result of such an unintentional change of position, especially where an x-ray beam of small dimensions is used, is readily apparent.

This deficiency of equipment can be obviated by the use of a head-holder which maintains the head in a fixed position by means of a chin rest and a vertex support (Figs. 1 and 2).

The chin rest consists of a small Lucite cup attached to an adjustable horizontal rod, which in turn is connected to a vertical rod supported on a metal block. Both rods are capable of movement to permit adjustment of the chin cup vertically and/or horizontally. The size and shape of the cup can be modified on an individual basis to fit a particular face and give additional support where necessary.

The metal block can be slid along a metal bar fixed to the underarm supports. The chin rest can thus be properly centered in the coronal plane. This metal bar is attached to one of the underarm supports by a hinge and is locked to the other by a bolt and nut through a groove. The underarm supports can be adjusted by sliding them along the grooves in the metal bars, thus facilitating the centering of the patient.

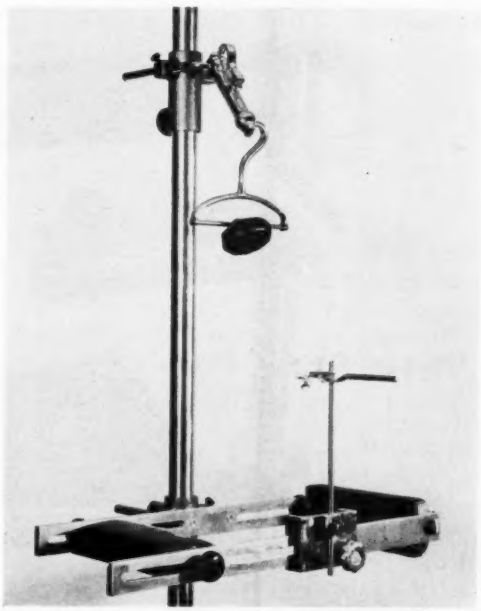


Fig. 1. Oblique view of head-immobilizing device.

There are several methods for constructing a suitable vertex support. In the device described here a head rest from a dental chair was adapted for attachment to the upright pole of the rotation apparatus. A head pad was employed to apply pressure against the vertex to hold the head in a fixed position. Figure 3 illustrates the use of the head-holder in two different positions (neutral and forward flexion), indicating the way the head might be placed during rotation.

Although the co-operation of the patient is still essential, the possibility of the tumor moving "off-center" is extremely remote with this device. This head-holder has been of material assistance

[1] From the Radiation Therapy Section, Walter Reed Army Hospital, Washington 12, D. C. Accepted for publication in August 1956.

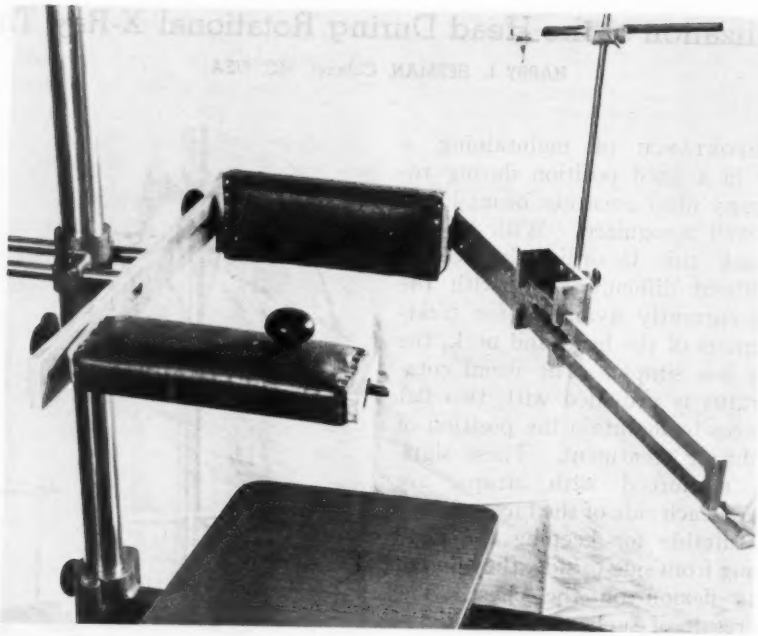


Fig. 2. Close-up of chin rest and its attachments.

Fig. 3. Immobilization of head during rotation therapy, in neutral position (left) and in forward flexion (right).

where physical weakness or postural unsteadiness might otherwise make the patient unsuitable for rotation therapy. Another advantage of the head-holder is the small amount of foreign material used about the head, giving the radiation therapist a wider latitude in adjusting the head to a desired plane of rotation.

SUMMARY

A head-immobilizing device for rotational x-ray therapy is described. This consists of a chin rest and a vertex support to hold the head in a fixed position and insure accurate beam localization.

Walter Reed Army Hospital
Washington 12, D. C.

SUMMARIO IN INTERLINGUA

Immobilisation del Capite in Therapia Rotational a Radios X

Es describite un dispositivo pro le immobilisation del capite in roentgenotherapia rotational. Illo consiste de un base pro le mento e un supporto pro le vertice, destinate a tener le capite in un position fixe e a assecurar le localisation accurate del fasce. Le dispositivio se ha provate utile in casos ubi le debilitate physical del patiente o su instabilitate postural poterea alteremente disqualificar le pro le therapia rotational.

A Device for the Localization of Dental Remnants in Edentulous Regions[1]

MORRIS OWEN, M.B., D.D.R.

IT IS THE OBJECT of this brief note to describe a device for facilitating the localization of dental remnants in edentulous regions of the alveolar margins by automatically reproducing on the film a centimeter rule. It has the advantages of accuracy and simplicity. The cost is so small that a measure is used once only, and discarded.

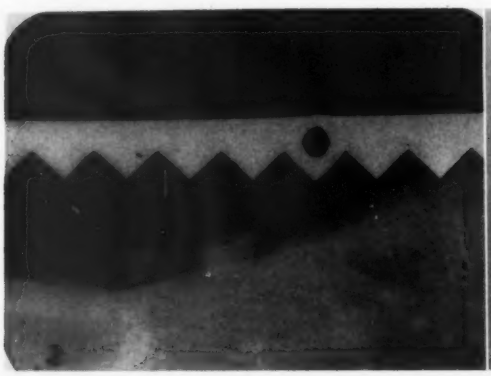
The device consists essentially of a lead ruler whose zero point is aligned with the mid-point of the alveolus (Fig. 1). The ruler is fixed to the tube side of the dental film with cellulose adhesive tape, in such a position that the film must include the region of the remnant. The x-ray exposure is made in the usual way. The processed film will show the remnant and also the image of the ruler, which indicates the distance of the remnant from the mid-line of the alveolar margin (Fig. 2).

Normal care must be exercised to ensure that the zero of the ruler has been accurately centered to the alveolar mid-line, and that the alveolar margin is not obscured.

Fig. 1. The intra-oral film has been positioned so that the zero of the rule is in the mid-line of the gum margin. The film is behind a remnant in the anterior region. The lip has been everted for easier illustration.

It will be seen that the essential feature of the lead ruler is its serrated edge, the teeth being at 0.5-cm. intervals. The hole in the center is 2.5 cm. from either end (Fig. 3).

It is obvious that any dental film may now be correctly orientated for reading, showing either an end or the central hole of the ruler. The distance of the remnant



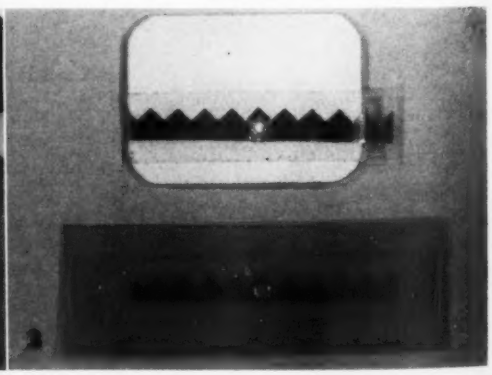


Fig. 2. Intra-oral radiograph (lower right). The measure shows the dental remnants lying between 3 and 4 cm. from the mid-line, measured along the alveolar margin.

Fig. 3. Above: Intra-oral film with rule in position for localization of remnant situated posteriorly in the right upper alveolus.

Below: The serrated lead strip and cellulose adhesive tape on protective backing for storage purposes.

[1] From the Royal Newcastle Hospital, Newcastle, New South Wales, Australia. Accepted for publication in July 1956.

from the mid-line of the alveolus is therefore apparent.

The lead used is the backing of commercial occlusal film packets, and the rules are made with pinking shears, trimming knife, and punch. Cellulose tape holds the completed rule on a piece of sheet plastic or x-ray film base, for storage. It has been found simplest to punch the hole after the rule and tape have been stuck to the backing.

For use, the rule, with the adherent tape, is peeled from the backing and attached, with this same tape, in an appropriate position on the dental film.

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SUMMARIO IN INTERLINGUA

Un Dispositivo pro le Location de Remanentes Dental in Regiones Edentule

Es describite un dispositivo que rende plus facile le location de remanentes dental in regiones edentule del margines alveolar. Illo consiste simplemente de un regula de plumbo con un margine serrate e un foramine al centro, 2.5 cm ab le duo extremitates. Le serrationes ha intervallos de 0.5 cm. Le regula es attachate per medio de bandas de cellulosa adhesive al latere del pellicula que da verso le tubo. In isto le zero es accuratemente centrate al linea medie alveolar. In le pellicula disveloppate le distantia del remanente ab le linea medie es apparente.

EDITORIAL

Sialography

Sialography, the procedure in which the duct system of a salivary gland is opacified by direct injection of a suitable contrast medium, was first described by Barsony (1) in 1925, about a year following the advent of cholecystography. Whereas cholecystography was universally adopted in one form or another as one of the most useful of all diagnostic procedures, sialography became a neglected stepchild of roentgen diagnosis. It was not completely abandoned but, on the other hand, it was not nurtured and developed to its fullest potential.

The reasons for indifference or downright disdain toward sialography on the part of most radiologists are not difficult to detect. The technic, which until recently had not been changed significantly since its inception, was time-consuming, tedious, and inexact. Because overinjection of a gland was commonplace, the procedure often proved profoundly painful to the patient, and the roentgenographic interpretation was, figuratively speaking, equally painful to the radiologist. Excess contrast medium escaping into the mouth following the open cannular method of injection added to the diagnostic confusion.

Recently, Rubin and Blatt (2, 3) described a modification of conventional sialography, the important features of which are: the use of a polyethylene catheter which is closed (stoppered) immediately following injection, the substitution of Pantopaque for iodized oil, and reflex stimulation of the salivary gland by lemon juice or chewing gum to hasten evacuation of the contrast medium. It is believed that more consistent, better controlled, less painful injection of smaller amounts of contrast medium can be achieved through the use of a less viscous material in a closed system and that inclusion of both pre-evacuation and post-evacuation films constitutes a more physiologic approach to the normal and diseased salivary gland. The technic is simple and expeditious, injection and filming together requiring only about twenty minutes on the average.

Study of a wide range of clinical material has established diagnostic criteria in both pre- and post-evacuation sialograms which, while far from perfect, are indeed gratifying. Intrinsic salivary gland neoplasms, which show retention of contrast material in post-evacuation films, can be differentiated from extrinsic tumors, which do not. Encapsulated intrinsic neoplasms, in which the general architectural pattern of the gland is preserved, usually can be distinguished from infiltrative lesions, which produce gross distortion of the gland structure in the filling phase and puddling of retained contrast medium in the evacuation phase.

It has long been recognized that sialography is of value in the detection of nonopaque calculi or inflammatory strictures causing obstruction of a main duct (*chronic obstructive sialodochiectasis*). Of greater current interest is the fascinating, heterogeneous group of inflammatory disorders which produce saccular dilatations of the peripheral ducts (so-called *sialectasis* or what is perhaps more accurately but more awkwardly designated as *chronic nonobstructive sialodochiectasis*). Included in this group are recurrent pyogenic parotitis in children or adults, Sjögren's syndrome, and Mikulicz's disease. Why this apparently diversified array of diseases produces such a similar and characteristic sialographic pattern is the subject of continued investigation. Considerable

light recently has been shed on the matter through systematic correlation of sialographic and histopathologic findings, thus emphasizing the value of sialography as an investigative as well as a clinical diagnostic tool.

Sjögren's syndrome, also known as the sicca syndrome, is a chronic disease of unknown etiology characterized basically by diminished lacrimation, a dry conjunctivitis and keratitis, dryness of the mucous membrane of the nose, mouth and throat, enlargement or atrophy of the parotid glands, and rheumatoid arthritis. Sialectasis appears to be a constant finding.

Two conditions involving the salivary and lacrimal glands bear the name of Mikulicz—Mikulicz's disease and Mikulicz's syndrome—and for this reason as well as for others, they are easily confused. The "disease," which runs a benign course and is of unknown etiology, is characterized by chronic, painless enlargement of the glands due to diffuse replacement of glandular parenchyma by lymphoid tissue. The "syndrome" has striking clinical similarities but apparently may be due to any one of a number of disease entities, among which are sarcoidosis, lymphoblastoma, tuberculosis, and syphilis.

Included in this issue of RADIOLOGY (page 477) is a provocative article dealing with *the abnormalities Mikulicz* which advances sialography's dual role in diagnosis and clinical research one step farther. Although there is always danger of enthusiastic investigators overstating their case when dealing with controversial issues, in this instance it appears that the authors are on solid ground, having presented their thesis convincingly and well. Previous reports of normal sialograms in Mikulicz's disease must be regarded with cautious skepticism in the light of the new observations.

It seems reasonable to state that sialography in general is considerably more useful than many of us have realized and fully deserves the more widespread application it now appears to be getting. One must remember, of course, that in sialography, as in any diagnostic procedure, the dividends paid in the form of successful results are directly proportional to personal investment of time, effort, and attention to detail.

JOHN F. HOLT, M.D.
University of Michigan

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COLORADO RADIOLOGICAL SOCIETY

At a recent meeting of the Colorado Radiological Society, Dr. R. Parker Allen, of Denver, was elected Councilor, and Dr. Wendell P. Stampfli, also of Denver, Alternate Councilor, to the American College of Radiology.

MISSISSIPPI RADIOLOGICAL SOCIETY

Newly elected officers of the Mississippi Radiological Society are: President, William G. McPheron, M.D., Jackson; Vice-President, James M. Packer, M.D., Jackson; Secretary-Treasurer, Robert P. Henderson, M.D., 316 Medical Arts Building, Jackson.

SOUTHERN RADIOLOGICAL CONFERENCE

At a joint meeting of the Alabama and Mississippi Radiological Societies, held in Point Clear, Ala., on Jan. 26–27, 1957, the Southern Radiological Conference was formed by members from Mississippi, Alabama, and Northwest Florida, for professional education and recreation.

Officers are: Dr. Tom B. Dominick, Vicksburg, Miss., Chairman; Dr. William D. Anderson, Tuscaloosa, Ala., Vice-Chairman; Dr. Marshall Eskridge, 1252 Springhill Ave., Mobile, Ala., Secretary-Treasurer.

SEVENTH INTERNATIONAL CANCER CONGRESS

The Seventh International Cancer Congress, sponsored by The International Union Against Cancer, will be held in London, England, July 6–12, 1958, under the Presidency of Sir Stanford Cade. There will be two main sessions: A. Experimental; B. Clinical and Cancer Control. Special emphasis will be placed upon Hormones and Cancer, Chemotherapy, Carcinogenesis, and Cancer of the Lung.

The registration fee for the Congress will be £ 10 or $30. The deadline for registration without payment of a late fee is Jan. 1, 1958. For registration forms and a preliminary program, application should be made to the Secretary General, Seventh International Cancer Congress, 45 Lincoln's Inn Fields, London, W. C. 2, England.

SOCIEDAD MEXICANA DE RADIOLOGIA

Recently elected officers of the Mexican Society of Radiology are: President, Dr. José Noriega L., D.M.R.; Secretary-General, Dr. Guillermo Santin, Calle del Oro No. 15, Mexico 7, D. F.; Recording Secretary, Dr. Enrique Alvarez Hernández; Treasurer, Dr. Baudelio Villanueva.

Regular meetings are held the first Monday of each month. A one-year course for radiographers, coordinated by Dr. Manuel Morales Duclaud, is conducted by the Society.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

POSITIONING IN RADIOGRAPHY. By K. C. CLARK, M.B.E., F.S.R. Honorary Fellow and Past President, Society of Radiographers; Radiographer, Princess Mary's Hospital (for Surgical Tuberculosis) and Margate (General) Hospital, 1922–27; Radiographer-in-Charge, Royal Northern Hospital, London, 1927–35; Tutor to X-ray Training School, 1930–35; Lecturer in Radiographic Technique for Postgraduate Courses in Medical Radiology, from 1940 D.M.R.E., from 1942 D.M.R. (London), from 1951 D.M.R. (Diagnosis), University of London, British Postgraduate Medical Federation; responsible for lecture course, Joint Hospitals Radiographic School (Charing Cross, University College and Westminster) for the Membership Diploma of the Society of Radiographers (M.S.R.) from 1953; Principal of the Department of Radiography and Medical Photography of Ilford Limited from 1935. A volume of 656 pages, with 2,150 illustrations. Published by Grune & Stratton, Inc., New York. Seventh edition, 1956. Price $29.00.

BASIC FOUNDATIONS OF ISOTOPE TECHNIQUE FOR TECHNICIANS. Edited by WILLARD C. SMULLEN, M.D., F.A.C.R., Radiologist in Charge, St. Mary's Hospital, Decatur, Ill. A volume of 164 pages, with 54 illustrations and 7 tables. Published by Charles C Thomas, Springfield, Ill., 1956. Price $4.75.

PROCEEDINGS OF THE THIRD NATIONAL CANCER CONFERENCE. Detroit, Michigan, June 4–6, 1956. Sponsored by American Cancer Society, Inc., and National Cancer Institute, U. S. Public Health Service. A volume of 962 pages, with numerous illustrations and tables. Published by J. B. Lippincott Company, Philadelphia, 1957. Price $9.00.

RADIATION SAFETY AND MAJOR ACTIVITIES IN THE ATOMIC ENERGY PROGRAMS. July–December 1956. A paper-bound volume of 396 pages, with photographs and tables. Issued by the

United States Atomic Energy Commission. Published by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 1957. Price $1.25.

DEATH OF A MAN. By LAEL TUCKER WERTENBACKER. A volume of 182 pages. Published by Random House, New York, 1957. Price $3.50.

RADIOLOGICAL DIAGNOSIS OF BRONCHIECTASIS. By CARL BENIGNUS ARTHUR JULIEN PUIJLAERT. A thesis leading to the degree of Doctor of Medicine in the University of Leiden. English translation by L. Stein, M.D. A monograph of 46 pages, with 44 roentgenograms. Published by H. E. Stenfert Kroese, N. V., Leiden, Holland, 1957.

LA POLYARTHRITE CHRONIQUE ÉVOLUTIVE. By L. ISEMEIN, Médecin des Hôpitaux de Marseille, and A.-M. FOURNIER, Médecin Électro-Radiologiste des Hôpitaux de Marseille, with the collaboration of P. Ciaudo, A. Trifaud, and Cl. Courtieux. With a preface by Professor F. Coste. A monograph of 316 pages, with 192 figures, including roentgenograms. Published by Masson et Cie, 120, boulevard Saint-Germain, Paris-6e, 1956. Price 3,200 fr.

ACTIONS CHIMIQUES ET BIOLOGIQUES DES RADIATIONS. Collection dirigée par M. HAÏSSINSKY. Deuxième série. I. Les effets chimiques produits par les rayons ionisants en phase gazeuse, by W. MUND. II. Phénomènes de luminescence provoqués par les rayonnements de grande énergie, by M. AGENO. III. Introduction à la dosimétrie des radiations, by N. MILLER. A volume of 222 pages, with 39 figures. Published by Masson et Cie, 120, boulevard Saint-Germain, Paris-6e, 1956. Price 2,800 fr. (paper bound), 3,400 fr. (cloth).

Book Reviews

RADIOLOGY OF THE HEART AND GREAT VESSELS. By ROBERT N. COOLEY, M.D., Professor and Chairman, Department of Radiology, University of Texas, Medical Branch, and ROBERT D. SLOAN, M.D., Professor and Director of the Department of Radiology, University of Mississippi Medical Center. Reprinted from the 3-volume loose-leaf edition of Diagnostic Roentgenology, edited by Ross Golden, M.D. A volume of 310 pages, with 195 figures. Published by Williams & Wilkins Co., Baltimore, Md., 1956. Price $12.00.

This monograph on the heart and great vessels was prepared as Chapter IV of Golden's (loose-leaf) *Diagnostic Roentgenology* and reprinted and bound for separate distribution. It furnishes a readable and moderately comprehensive review of the radiographic procedures used in the study of the cardiovascular system and their application to congenital and acquired heart lesions, with such physiologic and pathologic details as are necessary for an understanding and interpretation of the roentgen findings encountered in day-by-day practice.

The first fifty pages of the work are given over to a description of the procedures available to the radiologist in this field, together with many practical points of technic. A section on the normal heart follows, after which the various diseases and anomalies are considered. As would be expected, a generous proportion of the text is devoted to congenital heart disease. Diseases of the pericardium and of the aorta are subjects of special sections.

This is a welcome addition to the literature in a field that has come into special prominence in recent years. It will be of interest to both radiologist and cardiologist.

RADIUM THERAPY. ITS PHYSICAL ASPECTS AND EXTENSIONS WITH RADIOACTIVE ISOTOPES. By C. W. WILSON, M.Sc., Ph.D., F. Inst. P., Principal Physicist to the Westminster Hospital, London. Foreword by Sir Stanford Cade, K.B.E., C.B., D.Sc., F.R.C.S., M.R.C.P., F.F.R. A volume of 286 pages, with 73 text figures, and 21 plates. Published by Baillière, Tindall and Cox, London; The Williams & Wilkins Co., Baltimore. Second ed., 1956. Price $7.50.

This book is a revision of a monograph on the physical aspects of radium therapy first published in 1945. It was made necessary by the introduction of artificially produced radioactive isotopes and their increasing use as alternatives to radium and radon for therapeutic purposes. No attempt has been made to include the entire field of clinical applications of the isotopes. To quote from the author's preface: "An essential characteristic of the types of therapy dealt with in the original book is that in all cases the radioactive sources are disposed in relation to the patient in a manner directly controlled by the radiotherapist. Radioactive isotopes are now also being administered to patients either by injection or by mouth, and in this form of radiation therapy, a noteworthy fact is that, once administered, the radioactive material is largely out of control by the radiotherapist. This new edition does not deal at all with this latter form of therapy, but concentrates . . . upon therapy with controlled radioactive sources."

Starting with a discussion of radium, its properties and medical applications, the author continues with a discussion of the radioactive isotopes used in therapy. A section on the interaction of high-voltage radiation and matter is followed by a thorough discussion of dosimetry as applied to radium and radioactive isotopes. The chapters

on clinical applications include specific consideration of surface applicators, cavitary therapy, interstitial application, and the use of gamma ray beam therapy. Consideration is also given to problems of protection. An extensive bibliography is presented with each chapter, and appendixes contain tables useful in dosage calculation. Throughout the book, uses of radioisotopes are considered in parallel with the application of radium.

In both editions, the author has treated the subject of radium and radioisotope physics from the point of view of clinical application. The book is particularly valuable as a textbook to the postgraduate student in radiology, and as a handbook and work of reference for the practicing radiotherapist and radiation physicist. Tables, line drawings and photographs furnish ample illustrative material.

PHYSIOLOGY AND PATHOLOGY OF THE KIDNEY. A symposium by British writers under the Chairmanship of PROFESSOR ROBERT PLATT, University of Manchester. British Medical Bulletin Vol. 13, No. 1, January 1957. 70 pages, with numerous illustrations. Published by the Medical Department, British Council, 65 Davies St., London, W.1, England. Price $3.25.

Clinicians, pathologists, radiologists, physiologists, biochemists, and medical physicists have contributed to this symposium, which serves as an indication of work currently in progress in the field of renal pathology and physiology. Two brief articles are of radiologic interest. R. S. Murray, of the Radiodiagnostic Department of the London Hospital, and G. C. Tresidder of the Genitourinary Department of the same institution have collaborated on a paper on Renal Angiography. R. E. Steiner, of the Department of Radiology, Hammersmith Hospital, and Lecturer in Diagnostic Radiology in the Postgraduate Medical School of London, writes on Venography in Relation to the Kidney.

LA RADIOLOGIE CLINIQUE DE L'OESOPHAGE. By MARCEL BROMBART, Chef du Service de Radiodiagnostic à la Clinique César de Paepe, Bruxelles. With a preface by Pr. Ch. Auguste and an introduction by Pr. L. Deloyers. A volume of 466 pages, with 337 figures. Published by Masson & Cie, 120, boulevard Saint-Germain, Paris-6e, 1956. Price 4,400 fr., paper, 5,000 fr., cloth.

This monograph, although it contains nothing essentially new, is a thorough presentation of the knowledge accumulated to date on radiologic investigation of the esophagus. The technic of examination and the anatomic and physiologic aspects are thoroughly presented.

Before considering intrinsic lesions, the author discusses modifications of the course and caliber of the esophagus due to extrinsic conditions. These include affections of the spine, thyroid, pleura, aorta, heart, and mediastinal lymph nodes. Intrinsic lesions, as diverticula, esophagitis, ulcers, tumors, and such miscellaneous conditions as sideropenic dysphagia and scleroderma are considered separately. The importance of careful examination in the recumbent position to demonstrate varices is stressed, since radiography may be of prime importance in their clinical diagnosis.

LE DIAGNOSTIC DU CANCER D'ESTOMAC À LA PÉRIODE UTILE. By RENÉ A. GUTMANN, Collège de Médecine des Hôpitaux de Paris. A monograph of 260 pages, with 104 diagrammatic drawings in the text and over 300 figures included in 90 plates. Published by G. Doin & Cie, 8, Place de l'Odéon, Paris-6e, 1956. Price 4,300 fr.

In this monograph the author seeks to prove that the diagnosis of cancer of the stomach is possible at a time at which it can be cured by operation. It is pointed out that the usual clinical signs of cancer of the stomach are those of the advanced disease. Early cancer should be diagnosed when the patient feels relatively well, has not lost weight, and complains only of epigastric discomfort, symptoms of ulcer, or hemorrhage. Since cancer of the stomach may develop very slowly, the duration of symptoms cannot be used in determining the malignancy or benignancy of a lesion.

Early cancer of the stomach is not diagnosed by fluoroscopy nor even by exploratory laparotomy. Careful radiography of the barium-filled stomach with cognizance of early radiographic signs of malignancy is necessary. The half-filled stomach may easily lead to confusion. Small areas of rigidity which are constant on several radiographs are quite suggestive, though perigastric adhesions or a healing benign ulcer may simulate this appearance.

Certain morphologic aspects of gastric ulcer indicate malignancy in a high percentage of patients. These include the flat ulcer (*en plateau*), the ulcer in a depressed thickening of the gastric wall (*en-castrée*), the ulcer on a flat base, and the ulcer in a lacuna.

A malignant ulcer does not disappear with a therapeutic test. Most therapeutic tests, however, are insufficient. Daily intramuscular injection of oxy-feriscorbone or intravenous protein therapy is adequate. Gastroscopy is a complementary method of diagnosis but usually will not detect a cancer which cannot be seen on careful radiography. The radiographic atlas supplementing the author's text shows many proved cases to illustrate the various types of changes described.

This monograph is stimulating from the standpoint of inciting one to achieve proficiency in the early diagnosis of gastric cancer. It is provocative and will cause much discussion, but, if studied

carefully, it should indeed lead to earlier diagnosis of cancer of the stomach.

CLINIQUE ET RADIOLOGIE DE LA COLONNE VERTÉBRALE NORMALE ET PATHOLOGIQUE. CONFRONTATION ANATOMO-PATHOLOGIQUE. By PROFESSEURS G. SCHMORL and H. JUNGHANNS. French translation from the third German edition by Dr. J. L. Wolf Fried. A volume of 264 pages, with 403 figures. Published by G. Doin & Cie, 8, Place de l'Odéon, Paris 6e, 1956. Price 5,800 fr.

This is the French translation of the third German edition of the classic *Die gesunde und die kranke Wirbelsäule in Röntgenbild und Klinik*, which was reviewed in RADIOLOGY **58:** 744, 1952. All roentgenologists should be acquainted with this remarkable work. The illustrations in the French edition are a bit less "contrasty" than those in the German text, but they still retain the practically uniform excellence of the original edition.

DAS SKELETT DES KINDES. ENTWICKLUNG, BILDUNGSFEHLER UND ERKRANKUNGEN. By DOZ. DR. W. SWOBODA, Assistent an der Univ.-Kinderklinik Wien. A volume of 184 pages, with 222 illustrations. Published by Georg Thieme Verlag, Stuttgart, 1956. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York. Price DM 48.- ($11.40).

The opening chapter of this German monograph considers in detail the radiographic history of the developing skeleton. In words and pictures the reader is taken through the growth of a bone from its appearance at birth to its adult form. Continuity of thought leads quite naturally from the normal to general developmental diseases of the skeleton, such as dysostosis cleidocranialis, osteogenesis imperfecta, and marble bones. Related anomalies involving the entire body are illustrated in this same chapter under separate headings. Such localized disorders of formation as the craniostenoses, the facial dysostoses, and vertebral anomalies, maintain the sequence.

With the endocrine disturbances are included the fibrous dysplasias on the basis of Jaffe and Lichtenstein's observations. Rickets is the main topic in the portion of the book dealing with nutritional deficiencies. Quite surprisingly, the same chapter includes the aseptic necroses, apparently because the author interprets these ailments as localized nutritional disturbances. All the various types of eponymic aseptic necroses are charted and illustrated. Both bone tuberculosis and osteomyelitis receive brief mention. These ailments are no longer a major problem in modern society. An entire chapter is devoted to the reticuloses and the storage diseases. The final chapters, which are on bone tumors and bone trauma, are too sketchy to add significantly to the value of the book.

As compared with other organs the skeleton shows far greater differences in the growing and in the adult state. In infancy and childhood, many ailments are directly related to bone formation and bone growth. It is this that is leading to the formation of a new subspecialty, pediatric radiology. This book is another contribution to that field. Unlike most American books, such as Caffey's, the text includes little or no clinical material.

IN MEMORIAM

George Edward Pfahler, M.D.

1874–1957

Dr. George Edward Pfahler, looked upon for many years as expressing the highest ideals of medical radiology, passed away on Jan. 29, 1957.

Dr. Pfahler was born in Numidia, Columbia County, Pennsylvania, the son of William H. and Sarah Stein Pfahler. He received his early education in the local public schools and his medical degree from the Medico-Chirurgical College, Philadelphia, in 1898. Following his graduation he served for fifteen months as resident physician and then for three years as chief resident physician of the Philadelphia General Hospital.

An early interest in the clinical application of x-rays in medical practice led to Dr. Pfahler's appointment in 1902 as Clinical Professor of Symptomatology at the Medico-Chirurgical College, a position which he occupied until 1908. Concurrently he cultivated an interest in new ideas for using x-rays in clinical medicine at the Philadelphia General Hospital, becoming the first Director of its Department of Radiology (1899–1903). Meanwhile, the Medico-Chirurgical Hospital created a like department, of which he also served as Director (1902–1918). In 1909 he was made Clinical Professor of Radiology by the college, which subsequently advanced him to the rank of full Professor of Radiology (1911–1916), being the first college thus to recognize professorial rank for this new science.

When the Medico-Chirurgical College united with the University of Pennsylvania (1916), Dr. Pfahler was appointed Professor and Vice-Dean of the Department of Radiology in the Graduate School of Medicine (1916–1946), continuing to the time of his death as Emeritus Professor of Radiology in that institution.

During these years of academic achievement Dr. Pfahler organized and served as Director of the Radiological Departments of the Graduate Hospital in Philadelphia (1916–1932) and of Misericordia Hospital (1916–1943). He was also Consulting Radiologist to the Philadelphia General Hospital, Hahnemann Hospital, the Graduate Hospital, and the Woman's Medical College Hospital, all of Philadelphia. He was President of the American Roentgen Ray Society (1909–1910), first President of the American College of Radiology (1922–1923), and President of the American Radium Society (1921–1922).

Universal recognition of Dr. Pfahler's unique position as an organizer, teacher, and writer, with more than three hundred publications to his credit, was evinced by the numerous Gold Medals bestowed upon him by the Philadelphia County Medical Society (Strittmatter Medal) in 1903, the American Radium Society in 1935, the American Roentgen Ray Society in 1937, the Radiological Society of North America in 1951, the American College of Radiology in 1952, and the Centre Antoine Béclère of Paris, in 1955. This last was the *Centre's* first Gold Medal Award, "in homage to the pioneer who more than fifty years ago was lighting the field of radiology." He was also given Awards of Merit, by the American Cancer Society, Pennsylvania Division (1945), the Alumni Association of the Medico-Chirurgical College (1948), and the American Medical Association Foundation (1951).

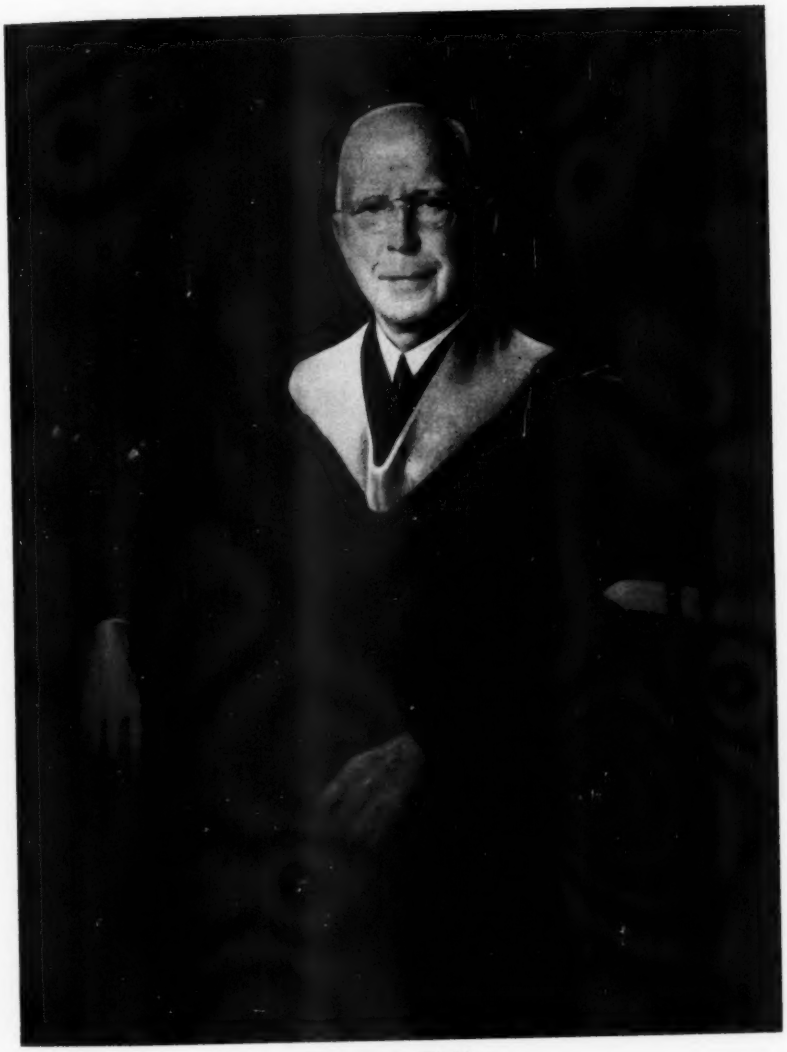
Dr. Pfahler's activities were not confined to the specialty of Radiology. He was a member of the Board of Directors of Ursinus College and of the Board of Directors of the Aid Association of the Philadelphia County Medical Society, of which he was President in 1952; Chairman of the Committee on Cancer Control of the Philadelphia County Medical Society, Philadelphia Division, for seven years, and later a member of its Board of Directors; and a member of the Medical Advisory Committee during World War I. The new Science Building at Ursinus College was named in his honor, Pfahler Hall of Science, in 1952.

On the international scene, Dr. Pfahler served on the Executive Committee for both the First and Second International Congresses of Radiology, in London (1925) and Stockholm (1928), as Honorary Vice-President of the Fifth and Sixth International Congresses in Chicago (1937) and London (1950), and as Vice-President Emeritus of the Seventh and Eighth Congresses in Copenhagen (1953) and Mexico City (1956). He was Honorary Vice-President of the Third International Cancer Congress (1938). He held honorary degrees from Cambridge, D.M.R.E. (1926), and from Ursinus College, Sc.D. (1930) and LL.D. (1942). He was also an Honorary Fellow of the Faculty of Radiologists, London, (1950).

Beside his membership in the national radiological organizations of his own country, Dr. Pfahler was an honorary member of radiological societies in France, Germany, Russia, Austria, Scandinavia, Cuba, Mexico, Panama, and Peru, and of the Radiological Section of London's Royal Academy of Medicine.

In their magnificent textbook, *Roentgen Diagnosis*, Professors Schinz, Baensch, and Friedel named Dr. Pfahler as one of the world's five pioneers in radiology, and the Arce Brothers of Madrid, in the dedication of their elaborate work to world leaders in the science of radiology, cited him as representing America.

Within this generation, there has been a deluge of



George E. Pfahler

discoveries in the fields of the basic sciences: Roentgen discovered x-rays; Becquerel found radioactivity in uranium; the Curies separated the radioactive element, radium, from pitchblende; and George Edward Pfahler determined the proper control and application of these discoveries for the medical world—a rich harvest, indeed, for a long and brilliant career. To us, the living, the quality of his achievements will ever be an illustrious example of devotion to duty, loyalty to friends, and dedication to the science of radiology. To the writer, personally, the genius and accomplishments of this great radiologist will always be a cherished memory.

BENJAMIN H. ORNDOFF, M.D.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY, *Secretary*, Theodore R. Miller, M.D., 139 E. 36 St., New York 16, N. Y.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, Barton R. Young, M.D., Germantown Hospital, Philadelphia 44, Penna.

AMERICAN COLLEGE OF RADIOLOGY. *Exec. Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6.

ASSOCIATION OF UNIVERSITY RADIOLOGISTS. *Secretary-Treasurer*, David M. Gould, M.D., University of Arkansas Medical Center, Little Rock, Ark.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, T. Leucutia, M.D., 10 Peterboro, Detroit 1, Mich.

SOCIETY OF NUCLEAR MEDICINE. *Secretary*, Robert W. Lackey, M.D., 452 Metropolitan Bldg., Denver 2, Colo.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. A. Meadows, Jr., M.D., Medical Arts Bldg., Birmingham 5.

Arizona

ARIZONA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. Lee Foster, M.D., 1313 N. Second St., Phoenix. Annual meeting with State Medical Association; interim meeting in December.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary*, E. A. Mendelsohn, M.D., Holt-Krock Clinic, Fort Smith. Meets quarterly.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, Austin R. Wilson, M.D., 540 N. Central Ave., Glendale 3.

EAST BAY ROENTGEN SOCIETY. *Secretary*, Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, Lewis J. Peha, M.D., 405 N. Bedford Dr., Beverly Hills. Meets monthly, second Wednesday, Los Angeles County Medical Association Bldg.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB. *Secretary*, H. B. Steward, Jr., M.D., 2920 Capitol Ave., Sacramento. Meets last Monday of each month, September to May.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually at time of California State Medical Association convention.

RADIOLOGICAL SOCIETY OF SOUTHERN CALIFORNIA. *Secretary-Treasurer*, Robert B. Engle, M.D., 318B W. California St., Pasadena.

SAN DIEGO RADIOLOGICAL SOCIETY. *Secretary*, C. W. Bruner, M.D., 2456 Fourth Ave., San Diego 1. Meets first Wednesday of each month.

SAN FRANCISCO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Irma Smith, M.D., 450 Sutter St., San Francisco 8. Meets quarterly, at Grison's Steak House.

SOUTH BAY RADIOLOGICAL SOCIETY. *Secretary*, Howard L. Jones, M.D., Palo Alto Hospital, Palo Alto. Meets monthly, second Wednesday.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, James T. English, M.D., 2000 Van Ness Ave., San Francisco 9. Meets third Thursday at 7:45, Lane Hall, Stanford University Hospital.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Lorenz R. Wurtzebach, M.D., 601 E. Nineteenth Ave., Denver 5. Meets monthly, third Friday, at University of Colorado Medical Center or Denver Athletic Club.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary-Treasurer*, Ralph J. Littwin, M.D., Bristol Hospital, Bristol. Meets bimonthly, second Wednesday.

District of Columbia

RADIOLOGICAL SECTION DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary-Treasurer*, Melvin O. Goodman, M.D., 1930 K St., N.W., Washington 6. Meets third Wednesday, January, March, May, and October, 8:00 P.M., in Medical Society Library.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, C. Robert DeArmas, M.D., 135 Broadway, Daytona Beach. Meets in April and in October.

GREATER MIAMI RADIOLOGICAL SOCIETY, *Secretary-Treasurer*, George P. Daurelle, M.D., Jackson Memorial Hospital, Miami 36. Meets monthly, third Wednesday, 8:00 P.M., at Mercy Hospital.

NORTH FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Marvin Harlan Johnston, M.D., Five Points Medical Center, Jacksonville 4. Meets quarterly, March, June, September, and December.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Bert H. Malone, M.D., 1406 Reynolds St., Brunswick. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Herbert M. Olnick, M.D., 417 Persons Bldg., Macon, Ga. Meets in November and at the annual meeting of the State Medical Association.

RICHMOND COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Wm. F. Hamilton, Jr., M.D., University Hospital, Augusta. Meets first Thursday of each month.

Hawaii

RADIOLOGICAL SOCIETY OF HAWAII. *Secretary-Treasurer*, Richard D. Moore, M.D., St. Francis Hospital, Honolulu 17. Meets third Monday of each month.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary-Treasurer*, R. Arthur S. J. Petersen, M.D., 11406 Parnell Ave., Chicago 28. Meets at the Sheraton Hotel, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Stephen L. Casper, M.D., Physicians and Surgeons Clinic, Quincy.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, George E. Irwin, Jr., M.D., 427 N. Main St., Bloomington.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, Chester A. Stayton, Jr., M.D., 313 Hume-Mansur Bldg., Indianapolis 4. Meets twice a year, first Sunday in May and during fall meeting of State Medical Association.

TRI-STATE RADIOLOGICAL SOCIETY (Southern Indiana, Northwestern Kentucky, Southeastern Illinois). *Secretary-Treasurer*, Robert E. Beck, M.D., 600 Mary St., Evansville, Ind. Meets last Wednesday, October, January, March, and May, 8:00 P.M., at the Elks' Club, Evansville, Ind.

Iowa

IOWA RADIOLOGICAL SOCIETY. *Secretary*, James T. McMillan, M.D., 1104 Bankers Trust Bldg., Des Moines. Meets during annual session of State Medical Society, and in the Fall.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer* G. S. Ripley, Jr., M.D., W. Iron Ave., Salina. Meets in the Spring with the State Medical Society and in the Winter on call.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary*, David Shapiro, M.D., Jewish Hospital, 217 E. Chestnut St., Louisville 6. Meets monthly, second Friday, at Seelbach Hotel, Louisville.

Louisiana

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets second Tuesday of each month.

RADIOLOGICAL SOCIETY OF LOUISIANA. *Secretary-Treasurer*, W. S. Neal, M.D., 602 Pere Marquette Bldg., New Orleans.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, W. R. Harwell, M.D., 608 Travis St. Meets monthly September to May, third Wednesday.

Maine

MAINE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Walter A. Russell, M.D., Augusta General Hospital, Augusta. Meets in June, October, December, and April.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary-Treasurer*, Nathan B. Hyman, M.D., 1805 Eutaw Place, Baltimore 17. Meets third Tuesday, September to May.

MARYLAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Nathan B. Hyman, M.D., 1805 Eutaw Place, Baltimore 17.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary*, E. F. Lang, M.D., Harper Hospital, Detroit 1. Meets first Thursday, October to May, at Wayne County Medical Society club rooms.

UPPER PENINSULA RADIOLOGICAL SOCIETY. *Secretary*, Arthur Gonty, M.D., Menominee. Meets quarterly.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, O. J. Baggenstoss, M.D., 1953 Medical Arts Bldg., Minneapolis 2. Meets three times a year, in Fall, Winter, and Spring.

Mississippi

MISSISSIPPI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert P. Henderson, M.D., 316 Medical Arts Bldg., Jackson. Meets monthly, on third Tuesday, at 6:30 P.M., at the Hotel Edwards, Jackson.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary-Treasurer*, D. R. Germann, M.D., University of Kansas Medical Center, Kansas City 3, Kans. Meets last Friday of each month.

GREATER ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Thomas F. Maher, M.D., 634 N. Grand Blvd., St. Louis. Meets on fourth Wednesday, October to May.

Montana

MONTANA RADIOLOGICAL SOCIETY. *Secretary*, John Stewart, M.D., Billings Clinic, Billings. Meets annually.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James F. Kelly, Jr., M.D., 816 Medical Arts Bldg., Omaha. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England

CONNECTICUT VALLEY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Thomas J. Crowe, M.D., 53 Center St., Northampton, Mass. Meets second Friday of October and April.

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary*, Raymond A. Dillon, M.D., 24 Wedgemere Ave., Winchester, Mass. Meets monthly on third Friday, October through May, at the Hotel Commander, Cambridge, Mass.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary*, Albert C. Johnson, M.D., 127 Washington St., Keene.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, George G. Green, M.D., 601 Grand Ave., Asbury Park. Meets at Atlantic City at time of State Medical Society and midwinter in Elizabeth.

New York

BROOKLYN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Harold N. Schwinger, M.D., 62 Eighth Ave. Meets first Thursday, October through May.

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Charles Bernstein, M.D., 685 Delaware Ave, Buffalo. Meets second Monday, October to May.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 2. Meets in January, May, and October.

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Ernest I. Melton, M.D., 2187 Ocean Ave., Brooklyn. Meets fourth Thursday, October to April (except December), at 9:00 P.M., Kings County Medical Bldg.

NASSAU RADIOLOGICAL SOCIETY. *Secretary*, Jerome Zwanger, M.D., 126 Hicksville Road, Massapequa. Meets second Tuesday, February, April, June, October, and December.

NEW YORK ROENTGEN SOCIETY. *Secretary*, John A. Evans, M.D., 525 E. 68th St., New York 21.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Irving Van Woert, Jr., M.D., Albany Hospital, Albany. Meets in the capital area second Wednesday, October, November, March, and April. Annual meeting in May or June.

RADIOLOGICAL SOCIETY OF NEW YORK STATE. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo. Meets annually with the State Medical Society.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, John W. Colgan, M.D., 277 Alexander St., Rochester 18. Meets at Strong Memorial Hospital, 8:15 P.M., last Monday of each month, September through May.

WESTCHESTER RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Arnold Myron Wald, M.D., 406 Boston Post Road, Port Chester. Meets third Tuesday of January and October and at other times as announced.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary*, William H. Sprunt, M.D., North Carolina Memorial Hospital, Chapel Hill, N. C. Meets in April and October.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, Marianne Wallis, M.D., Minot. Meets in the Spring with State Medical Association; in Fall or Winter on call.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John R. Hannan, M.D., 10515 Carnegie Ave., Cleveland 6.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Arthur R. Cohen, M.D., 41 S. Grant Ave., Columbus. Meets second Thursday, October, November, January, March, and May, 6:30 P.M., Fort Hayes Hotel, Columbus.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Arthur S. Tucker, M.D., 2065 Adelbert Road, Cleveland 6. Meets at 7:00 P.M., fourth Monday, October, November, January, February, March, and April, at Tudor Arms Hotel.

GREATER CINCINNATI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Morris M. Garrett, M.D., 630 Scott Str., Covington, Ky. Meets first Monday, September to June, at Cincinnati General Hospital.

MIAMI VALLEY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, H. D. Robertson, M.D., Miami Valley Hospital, Dayton 9. Meets monthly, second Friday.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sol Wilner, M.D., Medical Arts Bldg., Tulsa.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, N. L. Bline, M.D., 806 S.W. Broadway, Portland 5. Meets monthly, second Wednesday, October to June, at 8:00 P.M., University Club, Portland.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*. Robert Hanf, M.D., 807 South Auburn, Kennewick, Wash. Meets annually in May.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Walter P. Bitner, M.D., 234 State St., Harrisburg. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, Roderick L. Tondreau, M.D., 3400 Spruce St., Philadelphia 4. Meets first Thursday of each

month at 5:00 P.M., from October to May, in Thompson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, Norman Tannehill, M.D., 601 Jenkins Bldg., Pittsburgh 22. Meets monthly, second Wednesday, at 6:30 P.M., October to May, at the Hotel Roosevelt.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John H. Freed, M.D., 4200 E. Ninth Ave., Denver 7, Colo.

South Carolina

SOUTH CAROLINA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Samuel W. Lippincott, M.D., 103 Rutledge Ave., Charleston. Meets with State Medical Association in May.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Donald J. Peik, M.D., 303 S. Minnesota Ave., Sioux Falls. Meets during annual meeting of State Medical Society.

The Southeast

Southern Radiological Conference. *Secretary-Treasurer*, Marshall Eskridge, M.D., 1252 Springhill Ave., Mobile, Ala.

The Southwest

SOUTHWESTERN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Gordon L. Black, M.D., 1501 Arizona Bldg., El Paso.

Tennessee

MEMPHIS ROENTGEN SOCIETY. *Secretary*, Dan C. Gary, M.D., 36 S. Bellevue, Memphis 4. Meets monthly first Monday, John Gaston Hospital.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George K. Henshall, M.D., 311 Medical Arts Bldg., Chattanooga 3. Meets annually with State Medical Society in April.

Texas

DALLAS-FORT WORTH RADIOLOGICAL CLUB, *Secretary*, Albert H. Keene, M.D., 3707 Gaston Ave., Suite 116, Dallas. Meets monthly, third Monday, 6:30 P.M., at the Greater Fort Worth International Airport.

HOUSTON RADIOLOGICAL SOCIETY. *Secretary*, John M. Phillips, M.D., Hermann Hospital, Houston 25. Meets fourth Monday at the Doctors' Club.

SAN ANTONIO-MILITARY RADIOLOGICAL SOCIETY. *Secretary*, Hugo F. Elmendorf, Jr., M.D., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets at Brook Army Medical Center, second Wednesday of each month.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City 1. Meets third Wednesday, January, March, May, September, November.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, P. B. Parsons M.D., 1308 Manteo St., Norfolk 7.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Eva L. Gilbertson, M.D., 1317 Marion St., Seattle 4. Meets fourth Monday, September through May, at 610 Pine St., Seattle.

West Virginia

WEST VIRGINIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. Paul Elkin, M.D., 515–519, Medical Arts Bldg., Charleston. Meets concurrently with annual meeting of State Medical Society, and at other times as arranged by Program Committee.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Jerome L. Marks, M.D., 161 W. Wisconsin Ave., Milwaukee 1. Meets monthly on fourth Monday at the University Club.

SECTION ON RADIOLOGY, STATE MEDICAL SOCIETY OF WISCONSIN. *Secretary*, Abraham Melamed, M.D., 425 E. Wisconsin Ave., Milwaukee 2. Meets in October with State Medical Society.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursday at 4 P.M., September to May, Service Memorial Institute.

WISCONSIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Farrell F. Golden, M.D., 5221 Tonyawatha Trail, Madison 4.

Puerto Rico

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary-Treasurer*, Dr. R. B. Díaz Bonnet, Suite 504, Professional Bldg., Santurce, P.R.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, Guillaume Gill, M.D.; *Associate Honorary Secretary-Treasurer*, Robert G. Fraser, M.D. *Central Office*, 1555 Summerhill Ave., Montreal 25, Quebec. Meets in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTRO-RADIOLOGIE MÉDICALES. *General Secretary*, Ls Ivan Valée, M.D., Hôpital Saint-Luc, 1058 rue St-Denis, Montreal 18. Meets third Saturday of each month.

L'ASSOCIATION DES RADIOLOGISTS DE LA PROVINCE DE QUEBEC. ASSOCIATION OF RADIOLOGISTS OF THE PROVINCE OF QUEBEC. *Secretary*, Isadore Sedlezky, M.D., 3755 Cote St. Catherine Road. Meets four times a year.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPÍE DE CUBA. *Secretary*, Dr. Rafael Gomez Zaldívar. Offices in Hospital Mercedes, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA, A. C. *Headquarters*, Calle del Oro, Num. 15, Mexico 7, D. F. *Secretary General*, Dr. Guillermo Santin, Calle del Oro Num. 15, Mexico 7, D.F. Meets first Monday of each month.

PANAMA

SOCIEDAD RADIOLÓGICA PANAMEÑA. *Secretary-Editor*, Luis Arrieta Sánchez, M.D., Apartado No. 86, Panama, R. de P.

ABSTRACTS OF CURRENT LITERATURE

Roentgen Diagnosis

The Head and Neck

EBELING, P., AND ROBERTSON, E. GRAEME. Meningoencephalitis Due to Brucella abortus 600

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Meningoencephalitis Due to Brucella abortus. P. Ebeling and E. Graeme Robertson. M. J. Australia **1:** 1006–1009, June 16, 1956. (Royal Melbourne Hospital, Melbourne, Australia)

The authors report a case of meningoencephalitis due to *Brucella abortus*, with unusual encephalographic findings. The subarachnoid space over the brain had an extraordinary appearance, suggesting innumerable small cortical ulcers, areas of superficial atrophy, or multiple small excrescences superimposed upon slight shrinkage of the brain (since the subarachnoid space was widened). These observations are compared with the pathological appearances in the only case of *Brucella* encephalitis known to have come to autopsy (Hansmann and Schenken: Am. J. Path. **8:** 435, 1932). In this latter case meningeal "tubercles," granular ependymitis, and perivascular infiltration of the vessels penetrating the cortex and near the ventricular lining were found.

Within twenty-four hours after pneumoencephalography, the authors' patient became gravely ill with hyperpyrexia, complete aphasia, and right hemiparesis. This exacerbation of signs and symptoms was unique in a series of encephalographic examinations for many conditions. It was accompanied by a pronounced rise of the titer of *Brucella* agglutinins. Gradual subsidence of the disturbance was followed by general improvement.

Two roentgenograms; 2 tables.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

A Controlled Study of Cortisone Therapy for Headache After Pneumoencephalography. Orceneth A. Fly, Jr., Collin S. MacCarty, Robert P. Gage, Hector N. MacKinnon, and Peter H. Jones. J.A.M.A. **161:** 415–418, June 2, 1956. (Mayo Clinic, Rochester, Minn.)

Although pneumoencephalography is a procedure of undoubted value for the study of intracranial pathology, it is accompanied by a high rate of morbidity, primarily in the form of severe headache. The cause of this complication is still unknown. It has been variously attributed to persistent leakage of cerebrospinal fluid through the puncture hole, expansion of the injected air as room temperature gives place to body temperature, and to an inflammatory meningeal reaction.

The present study concerns the effect of cortisone on the incidence, severity, and duration of postpneumoencephalographic headache. A group of 50 patients received 50 mg. of cortisone by mouth at six-hour intervals for a total dose of 400 mg., beginning immediately after completion of the encephalographic studies. A control group of 47 patients received an inert placebo similar in appearance to the active medication and on a similar dosage schedule. None of the physicians participating in evaluation of the symptoms were aware of which patients received cortisone and which the placebo. The incidence of headache immediately following pneumoencephalography appears to have been about the same in the two groups, but its severity was decreased in patients receiving cortisone, particularly on the second postoperative and subsequent days. Length of hospitalization was also decreased slightly in the cortisone-treated patients. The effect of the quantity of gas introduced for the study was not great, but those receiving larger quantities of air or oxygen tended to have more prolonged headaches and to be more benefited by the cortisone. Those patients whose headaches appeared to be primarily on a psychogenic or functional basis did not respond well to the cortisone and did essentially as well with the placebo.

The authors suggest that headaches following spinal anesthesia or lumbar puncture for other reasons may be similarly benefited by cortisone, although they admit that the results in their series are not spectacular.

Six tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Hoarseness and Painful Deglutition Due to Massive Cervical Exostoses. Charles V. Heck. Surg., Gynec., & Obst. **102:** 657–660, June 1956. (6 N. Michigan Blvd., Chicago 2, Ill.)

The author reports 4 cases of dysphagia, accompanied in 3 instances by hoarseness and in 1 by a speech defect, which he attributes to large anterior hypertrophic spurs and exostoses of the cervical spine. One patient, however, had cranial nerve palsies attributed to a cerebrovascular accident and in another case there was a carcinomatous stricture of the cervical esophagus. In each of these cases the symptoms were of relatively recent onset and the part played by the spine lesions in their causation is debatable. In the other 2 dysphagia had developed gradually over a period of years without significant impairment of nutrition.

The roentgen findings in the 4 patients varied. Multiple adjacent joint levels were involved in each instance, with ankylosis of some of the segments. Where ankylosis at the site of the spurring was complete the spurs tended to be round and less prominent. If there was still considerable motion at the site they were quite sharp and prominent.

The author points out that a small spur may interfere with esophagoscopy, but a spur must be of large size to interfere with bronchoscopy.

Seven roentgenograms.

LESLIE M. ZATZ, M.D.
University of Pennsylvania

A Case of Bilateral Parotid Calculi. M. G. Varadarajan. Punjab M. J. **5:** 481–487, June 1956. (R. M. Hospital, Tanjore, India)

A case of bilateral parotid calculi in a thirty-eight-year-old male is reported. Left and right lateral roentgenograms disclosed two small, definitely outlined, oval shadows in the areas of the parotid glands, immediately behind and adjacent to the angle of the mandible. On the postero-anterior view of the mandible these shadows were not clearly visualized. A tentative diagnosis of parotid calculi was made.

In most instances, salivary calculi are rich in mineral salts (calcium carbonate) and can be clearly demonstrated roentgenographically. Sometimes, however, they are too small to be visualized, so that a negative x-ray examination does not completely exclude their presence. For locating calculi not readily demonstrated by other methods, the author recommends sialography as a safe and simple procedure, provided all manipulations are gentle. Iodized oil has been es-

tablished as the most satisfactory sialographic medium. The lateral oblique is the projection of choice for the submaxillary area and the true lateral is preferred for the parotid.

In the present case, sialograms of both parotids and submandibular glands were taken, the former in the lateral oblique and the latter in the lateral projection, with slight tilt of the x-ray tube toward the patient's head. The submandibular structures were found to be normal and the presence of calculi in the parotids was indicated. In this case, because the density of the calculi rendered them less radiopaque than the contrast medium, sialography was less helpful than plain roentgenography. The original diagnosis was confirmed on the basis of subsequent investigations made over the period of a year.

Six roentgenograms; 1 photograph.

A Note on Congenital Laryngeal Stridor. T. G. Wilson. Irish J. M. Sc., June 1956, pp. 279–281.

Lateral roentgenograms showed kinking of the trachea in 5 of 11 cases diagnosed as congenital laryngeal stridor. A similar finding was demonstrated in only 3 of 50 infants without stridor, and in these the kinking was of minor degree.

It has recently been agreed that congenital laryngeal stridor is attributable to softness and immaturity of the tissues of either the larynx (laryngomalacia) or the trachea (tracheomalacia). In this roentgenographic investigation, the kinking of the trachea is indicative of tracheomalacia.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

THE CHEST

Diffuse Progressive Interstitial Pulmonary Fibrosis (Hamman-Rich Syndrome). G. Schröder and H. Andersch. Fortschr. a. d. Geb. d. Röntgenstrahlen **84:** 706–709, June 1956. (In German) (Noldnerstr. 42, Berlin-Lichtenberg, Germany)

Idiopathic pulmonary fibrosis is a diffuse interstitial process with symptoms of cough, dyspnea, and cyanosis, a progressive course, and fatal termination. It is a rare disease of adult life, having been reported as early as the age of twenty and as late as the seventieth year. In acute cases, survivals are measured in weeks or months, while chronic cases have been followed for periods of three to nine years. The etiology is unknown. Therapeutically, corticosteroids have been tried but have afforded only temporary relief. The terminal phase, with respiratory and right heart failure, has resisted all attempts at treatment.

Histologically, there is diffuse interstitial fibrosis with thickening of the alveolar septa. The alveoli, however, almost always appear empty, in contrast to the findings in interstitial pneumonia. The thickening of the septa develops gradually through several stages, with edema with fibrinous deposits, fibroblasts, and collagenous connective tissue playing an important role. Inflammatory infiltration remains minimal. Occasionally, the bronchial epithelium undergoes squamous-cell metaplasia, and thickening of the arterial walls develops in the chronic stage. Perivascular and peribronchial fibrosis are almost completely absent.

A case is reported of a 46-year-old female in whom the disease was discovered on a routine roentgenogram of the chest. The patient was completely asymptomatic and physical and laboratory findings were negative except for fine râles over both lungs, suggesting diffuse bronchitis. The pulmonary markings were increased, with numerous small nodular and confluent streaky densities. Reticular structures were seen in both upper lung fields, while the lower lung fields were less involved. Hilar structures were only slightly increased in size and density. The heart and mediastinum were normal. Since tuberculosis, sarcoidosis, lymphangitis carcinomatosa, and occupational disease could be ruled out, a diagnosis of Hamann-Rich syndrome was arrived at. The disease was in a chronic stage without acute exacerbation.

One roentgenogram. ERNEST KRAFT, M.D.
Northport, L. I., N. Y.

Disseminated Pulmonary Calcification: Its Association with a Positive Reaction to Histoplasmin Antigen. Mark H. Joress and Boris Bushueff. New England J. Med. **254:** 1053–1058, June 7, 1956. (VA Outpatient Clinic, Boston, Mass.)

The authors provide a complete review of the literature in respect to epidemiologic investigations of histoplasmosis. It is evident that sources of infection with *Histoplasma capsulatum* occur elsewhere than in the Mississippi area. The fungus is said to be found most frequently in soil contaminated by chicken excreta.

The authors have studied in detail 20 cases of disseminated pulmonary calcification, with respect to exposure to soil dust, respiratory illness, findings on previous chest films, and reaction to the antigens of tuberculosis, coccidioidomycosis, and histoplasmosis.

The roentgen appearance of the lesions of histoplasmosis depends upon the phase of the infection. A pneumonitis is the most common early manifestation. Rarely is involvement limited to the hilar lymph nodes. About three-fourths of patients with parenchymal infiltration, however, show hilar node involvement. Calcification starts in the disseminated lesions soon after the initial lesions have resolved.

The differential diagnosis in primary histoplasmosis includes bacterial and viral pneumonia, Loeffler's pneumonia, tuberculosis, and neoplastic infiltration. Cases limited to the hilar nodes require differentiation from sarcoidosis, tuberculosis, blastomycosis, coccidioidomycosis, lymphoma, erythema nodosum, infectious mononucleosis, and certain pneumoconioses. A "coin" lesion is sometimes encountered in an inactive case of histoplasmosis and less frequently in the active phase of the infection, with or without central calcification. It is usually but not invariably single. Cavitation in histoplasmosis is rare. The most commonly observed chronic finding is disseminated calcified nodules, representing the arrested phase of the initial infection. These usually measure from 1 to 5 mm. in diameter.

The authors conclude that, although histoplasmosis occurs more frequently in the Central States area, infection in other localities should be kept in mind when the clinical history points to exposure to dust contaminated by the excreta of chickens, pigeons, and bats. Residua of the infection may be located in hilar lymph nodes or as granulomatous lesions in the lung, with or without calcification. Antigen skin testing is paramount in differentiating infection due to *M. tuberculosis* and *H. capsulatum*.

Five roentgenograms; 2 tables.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

The Fate of Children With Bronchiectasis. Christopher Strang. Ann. Int. Med. **44:** 630–656, April 1956. (Department of Thoracic Surgery, Shotley Bridge Hospital, Newcastle upon Tyne, England)

The author presents a study of 209 children with bronchiectasis who were followed for periods of two to fifteen years. In the majority of the series, symptoms began in early life (in 75 per cent in the first five years), following an acute respiratory infection. The most common initial illness was pneumonia, often associated with pertussis or measles. Tuberculosis is considered a rare etiologic agent in this age group.

Bronchography was carried out in the majority of cases to establish the site and extent of bronchiectatic involvement. The lower lobes were most commonly involved, with bilateral disease present in 28 per cent of the cases. The plain roentgenogram was considered normal in 25 of the children. It is interesting to note that, in 19 of these, the bronchiectasis was confined to the left lower lobe or lingula and was obscured in large part by the cardiac shadow. In 50 cases, a collapsed lower lobe was identified on plain films. Sinusitis was found in 63 per cent of 92 cases given an ear-nose-and-throat work-up. This was more common with bilateral bronchiectatic involvement.

One-hundred sixty-three of the patients in this series were treated surgically, either by pneumonectomy or lobectomy (including a few segmental resections). In the majority the results were good, and "there seems every reason to expect continued good health in these cases." Forty-eight of the group were cured of symptoms and 56 were greatly improved. There were 24 operative or postoperative deaths. Forty-six patients were treated medically, and for purposes of analysis 16 other medically treated cases are added to these. Some of this combined group had disease too advanced and some too mild for surgery. Some refused operation. Seventeen were cured or greatly improved; 17 died. In neither the surgically nor medically treated cases did follow-up films reveal any evidence to support the concept of bronchiectasis as a spreading process.

The author reviews the symptomatology of this disease and the medical management, including postural drainage and antibiotics. Surgical extirpation of the diseased segments is recommended whenever feasible.

One graph; 9 tables. GEORGE P. BACKER, M.D.
Indiana University Medical Center

Experimental Production of Bronchiectasis in Dogs. Jacques Delarue and René Abelanet. J. franç. de méd. et chir. thorac. **10:** 453–481, 1956. (In French) (Laboratory of Pathologic Anatomy of the Faculty of Medicine of Paris and Laboratory of Experimental Medicine of Paul-Brousse Hospital, Paris, France)

Attempts were made to learn more about the pathogenesis of human bronchiectasis by producing the disease in dogs. Changes similar to those in man were produced by non-stenotic bronchial irritation, thus indicating that stenosis is not necessary for the production of the disease.

Nervous and circulatory elements in the pathogenesis of bronchiectasis are indicated by the experimental production of unilateral bronchiectasis by alcoholic injection of vagosympathetic nerves in the neck.

Fourteen illustrations.

CHARLES M. NICE, JR., M.D., PH.D.
University of Minnesota

Pulmonary Changes in Welders. A Report of Three Cases. Robert Charr. Ann. Int. Med. **44:** 806–812, April 1956. (Jefferson Medical College of Philadelphia, Philadelphia 7, Penna.)

Pulmonary changes resembling silicosis may follow inhalation, over a period of years, in enclosed places, of welding fumes containing minute particles of iron oxide. These changes are generally considered harmless, but the author has seen 3 welders with respiratory complaints for which no other cause could be assigned. None of the 3 had been exposed to an atmosphere known to contain a hazardous concentration of silica. Essential symptoms were shortness of breath and cough. The roentgen findings were compatible with diffuse pulmonary fibrosis, and in 2 cases biopsy revealed fibrotic changes. Inhalation of vaporized bronchodilator drugs afforded symptomatic relief.

Three roentgenograms; 2 photomicrographs.

J. A. CAMPBELL, M.D.
Indiana University Medical Center

Pendular Motion of the Mediastinum. Philip Samet and William Anderson. Am. J. Med. **20:** 860–868, June 1956. (P.S., U. S. Public Health Service Hospital, Brooklyn 35, N. Y.)

Since there is normally little or no shift of the mediastinal structures to either side during the respiratory cycle, the level of negative pressure developed must be approximately equal in the two pleural cavities. Any mechanism permitting development of unequal pressures in the two hemithoraces will result in pendular motion of the mediastinum unless this structure is "fixed" by prior disease.

Five types of mediastinal respiratory shift are described in 21 patients. In Type I and Type II the mediastinum is mid-line on expiration but during inspiration is displaced toward the hemithorax which is the site of greater disease.

In Type III the mediastinum is displaced toward the involved side on inspiration and to the opposite side on expiration.

In Type IV the mediastinum is in the mid-line on inspiration but is displaced away from the site of lung disease on expiration. These patients have severe endobronchial stenosis and obstructive emphysema. In some instances the mediastinum may be displaced into the opposite side in both phases of respiration, but more on expiration than on inspiration.

In Type V the mediastinum is pulled into the diseased side during both phases of respiration as a result of complete endobronchial occlusion. This displacement occurs more on inspiration than on expiration.

Recent physiologic studies have demonstrated that pulmonary disease may result in decreased pulmonary compliance, that is, pressure difference between the pleura and mouth required to effect a given increase of lung volume with inspiration is increased. To effect a similar increase of lung volume on each side, unequal intrapleural pressures would thus be required in the two halves of the chest. More negative intrapleural pressure would be required on the diseased side on inspiration. The mediastinum would shift to this side with inspiration and return to the mid-line on expiration. Complete obstruction of some bronchioles in the diseased area in one lung is another possible cause for inspiratory mediastinal shift to the diseased side. In either case, increased resistance to pulmonary defor-

mation of the diseased side is responsible for the mediastinal inspiratory shift.

Sixteen roentgenograms; 1 table.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

Radiologic Evaluation of Chest Lesions in Children. Samuel B. Chapman. South. M. J. **49:** 119–124, February 1956. (306 E. 12th St., Kansas City 6E, Mo.)

The roentgen evaluation of chest lesions in children requires an understanding of the physiologic and developmental changes in the lung, as well as of the technical problems involved in obtaining adequate roentgenograms. In dealing with a sick child who cannot or will not co-operate, it has been found necessary to adopt flexible procedures rather than set rules for positioning and restraining. No unusual equipment is employed; an impulse timer, however, has been found to be most helpful, permitting exposures up to one-one hundred and twentieth of a second.

Examples typifying the problems in differential diagnosis are presented, primarily on the basis of the pathologic and physiologic changes as distinguished from etiologic considerations. The point is made that while etiologic diagnosis is not outside the realm of the radiologist the fundamental changes, which include infiltration, consolidation, vascular congestion, emphysema, and atelectasis, must first be recognized.

The author classifies chest lesions in children under four main headings, as follows: *congenital anomalies*, including tracheobroncho-esophageal variations and agenesis of a lobe or entire lung; *foreign bodies; infectious processes; neoplasms*, of which metastatic lesions are the most common. The roentgen findings for each of the foregoing are briefly reviewed.

Eight roentgenograms.

Basal Horizontal Lines on Chest Radiographs. Significance in Heart-Disease. R. E. Rossall and A. J. Gunning. Lancet **1:** 604–606, May 5, 1956. (R. E. R., Department of Medicine, University of Leeds, Leeds, England)

A review of the postero-anterior roentgenograms of 100 patients with mitral valve disease revealed basal horizontal lines in 63. No lines were found when the mean left auricular pressure was below 10 mm. Hg, but they were invariably present at mean pressures in excess of 24 mm. Hg. The relationship to mean pulmonary arterial pressure was less striking. No lines were seen with mean pulmonary arterial pressures below 24 mm. Hg, but they were consistently present above 51 mm. Hg. The chest roentgenograms of 16 patients with pulmonary hypertension arising from causes other than mitral disease were also examined. Two showed doubtful lines, and no lines were seen in the remaining 14; the findings in this group support the view that pulmonary hypertension alone is not the cause of the lines.

The relation of these lines to frank pulmonary edema is discussed. The authors believe that the recent appearance of lines in heart disease indicates a level of left auricular pressure not far below that necessary for production of pulmonary edema and that in such cases an early consideration of more intensive treatment, including valvotomy, is warranted.

In an addendum, attention is called to a paper by Bruwer, Ellis, and Kirklin (Circulation **12:** 807, 1955. Abst. in Radiology **67:** 452, 1956) which presents evidence, based on determinations of pulmonary arterial and pulmonary capillary pressures recorded during cardiac catheterization, that the pulmonary capillary pressure is the more important factor in the production of the basal horizontal lines. This is in accord with the authors' views.

Three illustrations; 2 tables.

Teaching of Chest Radiology to Medical Students. Charles T. Dotter. Dis. of Chest **29:** 691–692, June 1956. (University of Oregon Medical School, Portland, Ore.)

The method of teaching chest radiology to medical students at the University of Oregon Medical School, is based upon the premise that useful knowledge cannot be attained without practical experience. The main feature of the course is the assignment to the students of films with clinical data, for diagnosis. The cases are prepared as they might appear awaiting routine dictation in a radiology department or radiologist's office. In addition to submitting a written report, students informally present their radiographic findings and interpretations in subsequent discussion periods.

The author considers this method, although mildly unorthodox, "to be more effective than formalized lecture-demonstrations given in darkened rooms to students rendered drowsy by their inability to see clearly the actual radiographic findings being discussed."

THE CARDIOVASCULAR SYSTEM

Angiocardiographic Mixing Defects as Indicators of Left to Right Shunts. Melvin M. Figley, Björn Nordenström, Aaron M. Stern, and Herbert Sloan. Acta radiol. **45:** 425–437, June 1956. (University of Michigan Medical School, Ann Arbor, Mich.)

Areas of non-uniformity in the concentration of contrast material at the entrance of venous tributaries into the major veins and in the right atrium opposite the vena caval orifices are regularly observed during venous angiocardiography. At other locations such defects are abnormal. In the right heart and pulmonary artery, they may indicate a left-to-right shunt.

The authors examined the angiocardiograms of 75 patients with verified left-to-right shunts and made the following observations.

Patent Ductus Arteriosus: During venous angiocardiography the pulmonary artery and its branches are uniformly opacified. In the presence of a left-to-right shunt through a patent ductus, the jet of blood from the aorta results in displacement or dilution of the contrast material in the artery. The defect produced may be limited to the region of the ductus or extend to the pulmonary valve and is most frequently observed during ventricular diastole. The lateral or oblique projection demonstrates the defect to best advantage. In the presence of pulmonary hypertension where a reversal of the shunt has occurred, as might be expected, no defect is observed.

Ventricular Septal Defect: Ventricular shunts are usually visualized during ventricular systole and are best seen in the frontal, lateral, or right anterior oblique projection. Small mixing defects may be observed in the sinus or inflow portion of the right ventricle, but are more often seen in the outflow tract. The changing size and shape of the right ventricle as well as the

paucity of contrast material present in the right ventricular outflow tract at the end of ventricular systole make recognition of these defects difficult.

Atrial Septal Defect: Recognition of atrial septal defects is less straightforward than of other left-to-right shunts, as the right atrium also receives other streams of non-opaque blood, from the coronary sinus and opposite vena cava. Because of this, mixing defects can be considered indicative of left-to-right shunts only when these tributaries, particularly the opposite vena cava, are also opacified. In only 3 of 13 cases with uncomplicated atrial left-to-right shunts were diagnostic mixing defects present. These were visualized during atrial systole in the frontal and lateral projections.

Anomalous Insertion of the Pulmonary Veins: Venous mixing defects may be seen normally at the entrance of the jugular veins into the innominates, the azygos and innominates into the superior vena cava, and the iliac, renal, and hepatic into the inferior vena cava Elsewhere, mixing defects are abnormal and may serve to identify anomalously connected pulmonary veins.

In the past, recognition of left-to-right shunts by venous angiocardiography has depended upon the detection of recirculation of the contrast material through the lungs. Selective chamber enlargement and recirculation in certain chambers helped to localize the shunt. Often this evidence was insufficient; therefore a specific sign such as the one of the mixing defect is of advantage.

These mixing defects, however, are not constantly observed except in the presence of a patent ductus, and the necessity for catheter investigations of suspected left-to-right shunts is not obviated. In the diagnosis of a patent ductus the consistency of this sign has practical significance, particularly in infants, where both clinical diagnosis and catheterization may be difficult and indecisive.

As a result of their investigation, the authors believe that the differing incidence in the observation of these defects can be lessened by more rapid filming and shorter exposures. From the aspect of interpretation, the mixing defect must be distinguished from filling defects produced by intraluminal masses, such as neoplasms and thromboses, as well as incomplete dispersal of the contrast material.

Seventeen roentgenograms; 1 diagram; 1 table.

RITA M. BRADY, M.D.
University of California, S. F.

Blood Pressure and Heart Rate During Angiocardiography, Abdominal Aortography, and Arteriography of the Lower Extremities. A. K. Amundsen, P. Amundsen, and O. Müller. Acta radiol. **45:** 452–458, June 1956. (Roentgen Department, Ullevål Sykehus, Oslo, Norway)

This paper is concerned with the time of occurrence and duration of the fall in peripheral arterial pressure that follows the injection of contrast media for angiocardiography, aortography, and peripheral arteriography.

Twenty-six patients were studied. Angiocardiography was carried out 16 times on 9 patients, aortography 12 times on 10 patients, and arteriography 9 times on 7 patients. During these procedures, the blood pressure in the aorta was measured from shortly before the injection to thirty seconds following it by a pressure sensitive apparatus of the strain-gauge type. The pressure tracing was recorded on an Elmquist Triplex electrocardiograph together with an electrocardiogram and seriogram. Nycotrast (Diodone) 70 per cent was used in most instances, but was sometimes replaced by a 50 per cent preparation for peripheral arteriography.

The investigation revealed that the blood pressure fell more rapidly in aortography than in angiocardiography. In angiocardiography, a definite fall was observed following completion of the injection, the average decrease in the pressure recording being 16 mm. of mercury. The fall continued for thirty to forty seconds, with a mean of 30 and 40 mm. of mercury, respectively. One minute after the end of the injection the pressure again started to rise. In the majority of cases, the injection appeared to have relatively little effect on the heart rate. Within a few seconds after the injection, a slight decrease in heart rate, shortly followed by a minimal increase, was the usual pattern.

During aortography a slight increase in the blood pressure preceded its fall, which occurred within ten seconds after commencement of the injection, the mean decline being 30 mm. of mercury at twenty seconds and 39 mm. at forty seconds, which was maximum. There was a slight bradycardia during the brief rise in blood pressure, a tachycardia ensuing when the pressure commenced to fall.

The behavior of the heart rate and blood pressure observed during peripheral arteriography was similar to that during aortography, except that in the former the deviations were less.

Despite the similar blood pressure responses in aortography and angiocardiography, the alteration in the heart rate differed. During aortography there was a concomitant increase in the heart rate during the blood pressure fall, whereas during angiocardiography a bradycardia accompanied the blood pressure decline. The aortic carotid sinus reflex can account for this reaction during aortography but it is thought that the initial bradycardia observed during angiocardiography ensues from a vagal stimulation originating in the lungs or heart, or possibly from the direct effect of the contrast medium on the heart muscle.

Nycotrast appears to have a definite peripheral vasodilating effect. Blood pressure curves during pressure fall support this. These curves have been previously described by Wiggers as typical of low resistance in the aortic area.

Seven illustrations.

RITA M. BRADY, M.D.
University of California, S. F.

The Physiological Effect of Contrast Media Used for Angiocardiography. George G. Rowe, John H. Huston, H. Tuchman, George M. Maxwell, Arvin B. Weinstein, and Charles W. Crumpton. Circulation **13:** 896–904, June 1956. (Cardio-Pulmonary Research Laboratory, University of Wisconsin, Madison, Wisc.)

In a series of 283 angiocardiographic studies of 249 patients, there were 5 deaths attributable to the procedure. The authors report these and also describe experimental studies on dogs to determine the physiologic effects of contrast media injected for this purpose. All 5 fatalities followed the use of Neo-Iopax, which is the medium chiefly used in the institution from which the report comes. Four of the patients were infants, 3 with atrial septal defects and 1 with tetralogy of Fallot. The fifth patient was a woman of fifty with

severe mitral stenosis. The studies in dogs were done with 75 per cent Neo-Iopax, 70 per cent Diodrast, and 70 per cent Urokon.

The experimental observations included, generally, a transient slowing of the heart rate, followed by an acceleration, with a return to normal, all within a few minutes; also elevation of right atrial and pulmonary arterial pressure (attributed at least in part to the viscosity of the solutions), followed by systemic hypotension (attributed to the vasodilatory effect of these agents) and tachycardia.

These observations are in accord with the concept that immediate death in angiocardiography may be related to right-to-left shunts which cause venous blood and contrast substance to enter the systemic vessels and precipitate fatal medullary depression. Elevation of right atrial pressure produced by a contrast substance may reverse a left-to-right shunt significantly. In conditions such as tetralogy of Fallot or patent ductus with pulmonary hypertension, the drop in systemic arterial pressure due to contrast medium could cause a further hazardous decrease in pulmonary flow.

Six figures; 1 table. CAPT. GARTH R. DREWRY
U.S.A.F. Hospital, Tampa, Fla.

The Significance of Aortography for the Diagnosis of Abdominal Aneurysms. G. Aurig and H. Radke. Fortschr. a. d. Geb. d. Röntgenstrahlen **84:** 661–670, June 1956. (In German) (G. A., Zentral-Rontgeninstitut, Stadtisches Krankenhaus im Friedrichshain, Leninallee 171, Berlin NO 18, Germany)

An abdominal aortic aneurysm can usually be suspected on ordinary roentgenograms on the basis of one or more of the following signs: displacement of the ureters and duodenum, tilting of the kidneys, obliteration of a psoas line, pressure defects of lumbar bodies, and curvilinear streaks of calcium, especially in the left lumbar area. However, supplementary translumbar aortography for specific information is now considered vitally important from a surgical standpoint. With this procedure, the exact size and extent of the aneurysm can be determined preoperatively.

For the translumbar injection of contrast material the D-12 level is recommended. No higher level is necessary since most aneurysms are distal to the origin of the renal arteries. Six cases are discussed, in which no complications have been experienced.

With aortography, the authors have been able to differentiate between true and false aneurysms and dissecting aneurysm. The following forms are described and illustrated: cylindric, fusiform, scaphoid, saccular, and serpentine. In all cases tests for syphilis were negative and the aneurysms were believed to be of arteriosclerotic origin. The circulation time in the involved section of the aorta is greatly prolonged—to as much as four or five times the normal. As a result, the left ventricle becomes dilated and pulmonary congestion ensues. There is also evidence of diminished blood supply to the peripheral vessels in the lower extremities.

Fourteen roentgenograms.

ERNEST KRAFT, M.D.
Northport, L. I., N. Y.

Paraplegia Secondary to Abdominal Aortography. Joseph G. McCormack. J.A.M.A. **161:** 860–862, June 30, 1956. (VA Hospital, Oakland, Calif.).

A 58-year old male was seen with a history of severe pain and cramping in both lower legs for a period of two years. Past history revealed a "stroke" with right-sided hemiplegia three years previously. Physical examination showed no palpable aortic pulse in the abdomen and no definable pulse in the femoral arteries or any distal vessels. In view of these observations, a diagnosis of aortic obstruction was considered and a left lumbar sympathectomy was performed in an attempt to relieve the pain and improve the collateral circulation to the left leg. At the same time a direct injection of contrast medium into the abdominal aorta was made for study of the distal aorta and iliac arteries. The medium used was 70 per cent Urokon.

The initial injection of 15 c.c. resulted in good arterial filling and showed complete obstruction above the bifurcation of the aorta. After a delay of about fifteen minutes a second injection of 20 c.c. was made to demonstrate the upper limit of the block just below the renal vessels. There was no immediate reaction, but about sixteen hours later complete paralysis of the lower extremities occurred, from the level of D-8 down. Neurological studies led to a diagnosis of transverse myelitis. Death occurred five days later, following development of left ventricular failure and severe pulmonary edema. Autopsy showed an old funnel-shaped thrombus extending downward from a point just inferior to the renal arteries, with complete obstruction of the aorta below the level of L-3. The spinal cord appeared grossly normal.

The author attributes this reaction to the direct toxic effect of the contrast material (Urokon) on the nerve tissue of the spinal cord. Because of the almost complete block of the aorta by the thrombus, the aortic blood stream was channeled into the dilated right third and fourth lumbar arteries, which served as the main take-off collaterals for the aorta at this level. By way of these vessels there was a rapid delivery of a high concentration of contrast material to the nerve tissue of the spinal cord, through the spinal arteries and their rich anastomoses.

Since a 50 per cent solution of Urokon has been found fully as satisfactory as 70 per cent, the author has adopted the more dilute preparation since this unfortunate incident. He also advises a lapse of seven to ten days before a second injection should this be required.

One drawing; 2 photomicrographs.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Combined Tricuspid and Pulmonary Atresia with Juxtaposition of the Auricles. A. M. Stewart and A. Wynn-Williams. Brit. J. Radiol. **29:** 326–330, June 1956. (A. M. S., Radiodiagnostic Department, Royal Hospital for Sick Children, Aberdeen, Scotland)

A case of combined tricuspid and pulmonary atresia in a female infant of thirty months, with associated underdevelopment of the auricles, is reported. Pertinent radiologic features were: concave left upper heart border, suggesting absence of the normal pulmonary conus; left-sided aorta with slight right displacement at its origin; flattening of the pulmonary outflow tract; left ventricular enlargement with high blunt apex requiring marked rotation to clear the spine (no evidence of right ventricle); narrow waist of the heart because of the small pulmonary artery and dextroposed aorta.

The patient died some five weeks after hospital ad-

mission. Autopsy revealed an ante mortem thrombus distal to a stenosis in the left pulmonary artery; a pseudotrilocular heart with two atria but a deficient septum; a large left ventricle with small ventricular septal defect and a rudimentary right ventricle; absence of the right atrioventricular and pulmonary valves; a left atrioventricular valve with three cusps; dextroposed aorta and partially closed ductus arteriosus.

Three roentgenograms; 5 photographs; 1 diagram.

W. C. TALLEY, M.D.
University of Arkansas

The Diagnostic Value of Percutaneous Splenoportography. M. Róth and I. Jóna. Schweiz. med. Wchnschr. **86**: 738–741, June 23, 1956. (In German) (Chirurgischen Fortbildungsklinik der medizinischen Universität Budapest, Budapest, Hungary)

The most significant indication for splenoportography is portal hypertension. This is classified as (*a*) prehepatic, as a result of developmental hypoplasia (Cruveilhier-Baumgarten syndrome) or more commonly of portal thrombosis; (*b*) intrahepatic, which is the most frequent type, produced by cirrhosis; (*c*) posthepatic, resulting from thrombophlebitis of the hepatic veins.

Splenoportography is performed by injecting 20 to 50 c.c. of 70 per cent organic iodinated contrast medium with a needle introduced through the skin into the middle of the splenic area (determined by percussion and/or roentgenoscopy), the site of puncture being usually in the tenth intercostal space, on the anterior axillary line. Three or four exposures are made with the patient supine, at one- to two-second intervals.

The procedure is of considerable assistance in determining which type of portocaval shunt is likely to give best results in the individual case, even though the decision to operate depends upon the clinical findings (varices, ascites). It is also of help in the diagnosis of hepatic and pancreatic tumors, both primary and metastatic.

In the authors' series of 17 cases, there were no significant accidents, which would obviate the need for performing the procedure on the operating table, just prior to laparotomy. Four brief case histories are included.

Six roentgenograms.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Extrahepatic Portal Hypertension (Portal Vein Thrombosis) Diagnosed by Percutaneous Splenic Venography. Hector F. Rodriguez, Rafael Diaz Bonnet, and David Rodriguez-Perez. Ann. Int. Med. **44**: 772–780, April 1956. (H. F. R., 13 Mayor St., Ponce, Puerto Rico)

A case of portal vein thrombosis diagnosed by percutaneous splenic venography prior to surgical intervention is presented. Diodrast 70 per cent (30 c.c.) was injected into the spleen by the subcostal route, outlining the splenic vein and collateral channels. A thrombosis of the portal vein with extension into the splenic vein was demonstrated and was substantiated at surgery. No complications were encountered. Comparison is made with a normal venogram and with a case of intrahepatic portal hypertension secondary to schistosomiasis.

Hypertension of the portal circulation develops from obstruction to its flow, either within or outside the liver. Extrahepatic causes, in addition to portal and splenic vein thrombosis, include cavernous transformation of the portal and splenic veins, hepatic vein thrombosis, and the Cruveilhier-Baumgarten syndrome; intrahepatic causes include, among others, portal and biliary cirrhosis.

The presence of portal hypertension can usually be established by demonstrating widening of the splenic or portal veins; esophageal varices are also present. The surgeon can be alerted as to the type of shunt to be performed. The procedure is also useful in establishing the patency of a portocaval shunt postoperatively.

Four roentgenograms.

GEORGE P. BACKER, M.D.
Indiana University Medical Center

THE DIGESTIVE SYSTEM

Congenital Tracheoesophageal Fistula Without Atresia of the Esophagus. Richard Koch and John M. Clark. J. Dis. Child. **91**: 636–640, June 1956. (University of Southern California School of Medicine, Los Angeles, Calif.)

The authors report in detail what they believe to be the sixteenth case of surgical correction of a tracheoesophageal fistula without esophageal atresia in the American literature. Characteristically the signs and symptoms in infants with this anomaly are due to aspiration of liquids into the lungs, with choking, coughing, and cyanosis, all more marked during feedings, leading to recurrent pneumonitis and malnutrition.

Embryologically the esophagus increases in length more than the trachea, so that a persistent fistula is stretched, with its higher, posterior, level in the trachea and the lower, anterior, level in the esophagus. Routine roentgenography with the infant in the supine position will thus often fail to reveal the small fistulous tract from the anterior surface of the esophagus to the trachea, in the absence of pooling of the medium in an atretic esophagus.

With a small amount of contrast material, 2 or 3 ml., instilled into the mid-esophagus *via* a catheter, the tendency to obscure the narrow fistulous tract is avoided. Further, if the infant is placed in the prone position, the smaller amount of medium will gravitate to the anterior wall of the esophagus and thus outline the fistula running upward and forward to the trachea. Every effort should be made to prevent regurgitation into the pharynx, with a resultant confusion of diagnosis from aspiration.

Radiographs reveal tenting of the anterior wall of the esophagus and the tapering curve, upward and forward, of the fistulous tract. The medium will then puddle as it enters the trachea, so that the roentgen appearance resembles the spout of a teapot.

Four roentgenograms.

SAULS CHEFF, M.D.
Boston, Mass.

Diagnosis and Differential Diagnosis of Chronic Supracardial Changes of the Lower Esophagus. H. Kamieth. Fortschr. a. d. Geb. d. Röntgenstrahlen **84**: 681–690, June 1956. (In German) (Strahleninstitut der Universität des Saarlandes im Landeskrankenhaus Homburg, Homburg, Germany)

Lesions of the lower esophagus and the cardia are operated on successfully with ever increasing frequency. This achievement challenges the ingenuity and resourcefulness of the roentgenologist, since precise differentiation between chronic inflammatory changes, neoplastic lesions, and extrinsic factors is more vital than ever.

A painstaking mucosal study of the lower esophagus is necessary, and for this the author recommends the double-contrast technic, with swallowing of air prior to ingestion of barium. Barium mixtures of various consistency are sometimes necessary for optimal visualization of the mucosal pattern. The patient should be in the horizontal or preferably the headdown position. A right anterior oblique projection is most helpful, and spot films in deep inspiration and expiration are advised.

Chronic inflammatory changes of the supracardial area are manifested by stenosis, circular spasm, and tent formations. Esophageal ulcer and esophagitis are frequently associated findings. Of special interest is the observation that the irregular marginal contour of the involved segment will change its shape in the various phases of respiration and may be completely flattened in deep inspiration.

Five representative cases are discussed and illustrated. The first case was originally mistaken for carcinoma of the lower esophagus, but mucosal study revealed only chronic inflammatory changes with stenosis. At esophagoscopy a plum pit was discovered in the lower esophagus. In the second case it was important to determine preoperatively whether or not a proved carcinoma of the cardia had involved the lower esophagus. Extension of the neoplasm in an upward direction, with beginning esophagitis at its upper border, was discovered and later verified. The third patient had a carcinoma of the gastric fundus with recent weight loss, dysphagia, and supracardial stenosis. The latter proved to be due to extrinsic pressure from extramural spread of the neoplasm. In the fourth patient, with chronic recurrent duodenal ulcer, peri-esophageal adhesions, as well as a small ulcer of the lower esophagus, could be demonstrated. The fifth case was one of para-esophageal hernia with hiatus insufficiency and peri-esophageal adhesions.

Nineteen roentgenograms.

ERNEST KRAFT, M.D.
Northport, L. I., N. Y.

Diverticula of the Lower Part of the Esophagus. A Clinical Study of One Hundred Forty-Nine Nonsurgical Cases. Harold C. Habein, Jr., Herman J. Moersch, and John W. Kirklin. Arch. Int. Med. **97**: 768–777, June 1956. (Mayo Foundation, Rochester, Minn.)

This report is based on a study of 149 lower esophageal diverticula seen at the Mayo Clinic, 97 pulsion diverticula and 52 of the traction type. None of the patients were treated surgically.

The ratio of males to females in the series was approximately 2 to 1. The average age was about fifty-eight years, with a range from thirty-four to eighty-one years. Pulsion diverticula were more commonly seen on the right side, but the traction variety occurred somewhat more frequently on the left.

Pulsion diverticula in this series varied from 0.5 cm. to 9.5 cm. in the largest dimension. They had a short but usually roentgenologically definite neck. They were found at all levels in the lower esophagus from the diaphragm to 10 cm. proximal to the esophageal hiatus.

The traction diverticula were rather small, none exceeding 3.0 cm. in diameter. These diverticula are broad based and flat with no real neck, as seen roentgenologically, and the sac is not dependent.

The clinical manifestations of lower esophageal diverticula are extremely variable and unpredictable. It is possible for a large pulsion diverticulum to remain unchanged for years and never cause significant symptoms. On the other hand, a rather small diverticulum may produce considerable disability.

About 15 to 20 per cent of pulsion diverticula of the lower esophageal region produce definite symptoms. A similar proportion of patients will have symptoms due primarily to associated esophageal lesions, which are present in from 50 to 70 per cent of patients with lower esophageal diverticula.

Traction diverticula in the lower esophagus practically never by themselves produce symptoms.

Asymptomatic lower esophageal diverticula should not be operated upon unless they show considerable increase in size on repeated roentgen examination. A diverticulum causing mild symptoms in a poor risk patient may be treated conservatively with expectation of good results for relatively long periods. In younger patients, it is usually not justifiable to temporize in the presence of significant symptoms.

Twelve roentgenograms; 4 tables.

THEODORE E. KEATS, M.D.
University of Missouri

Oesophageal Reflux. An Analysis of 453 Consecutive Barium Meal Examinations. J. H. L. Conway-Hughes. Brit. J. Radiol. **29**: 331–334, June 1956. (Royal Isle of Wight County Hospital, Ryde, I. W.)

In a consecutive series of 453 upper gastrointestinal barium studies, esophageal regurgitation occurred in 12 per cent in the supine position (free reflux); in an additional 9 per cent reflux developed when abdominal pressure was increased (forced reflux). Among the patients examined were 29 referred from the Ear, Nose, and Throat Department because of chronic sore throat, a feeling of constriction or a lump in the throat, difficulty in swallowing, or pain in the chest for which there was no obvious cause. Of this group 52 per cent were found to have esophageal reflux, which points to the symptoms mentioned as an indication for examination with the latter condition in mind.

Males predominated in the series, numbering 265; 12.5 per cent of these showed reflux; in the 188 females the incidence was 32.5 per cent. Pregnancy did not appear to be a contributing factor. Regurgitation was a common finding in all age groups. Associated findings were duodenal ulcer in approximately 13 per cent, gastric ulcer in 9 per cent, and sliding hiatus hernia in 7 per cent. Most frequently reflux occurred as an isolated phenomenon.

[There are several mathematical—or perhaps typographical—errors in this paper, but fortunately these do not affect the overall analysis.—H. J. B.]

Eight tables.

HOWARD J. BARNHARD, M.D.
University of Arkansas

Results of Surgery in Carcinoma of the Stomach Discovered by Periodic Roentgen Examination. John R. Amberg and Leo G. Rigler. Surgery **39**: 760–775, May 1956. (University of Minnesota Medical School, Minneapolis, Minn.)

The authors present their findings in a group of 39 cases of gastric cancer discovered by serial roentgen examination. Although the five-year survival rates are not yet available, it appears that a substantial increase in the number of cases subject to surgical resection and cure may be obtained by serial roentgen study of relatively symptomless individuals.

The 39 cases were selected from a group of 78, in which initial roentgen examination of the stomach had either been negative or had indicated the presence of a non-malignant lesion, while subsequent examination led to the diagnosis of gastric cancer. Two groups among the 78 were discarded: the first (21 patients) because of little significant change in the roentgen appearance of the lesion from one examination to the other, indicating that the tumor was no longer in an early stage of development; the second (18 patients) because the interval between roentgen examinations was more than four years. In the remaining 39 cases, the interval between examinations ranged from six to forty-eight months, with a median of fourteen months. The group was composed of 25 men and 14 women; the median age was seventy-one years.

The data considered most significant concern lymph node involvement, which is closely related to the stage of advancement of the disease and its prognosis. In 18 of the 39 cases there was no spread to the regional nodes. Fifteen of this negative group were among those in whom the interval between roentgen examinations was from six to eighteen months. The rate of growth of the primary lesion varied from case to case, but any considerable increase in size in six months to a year was unusual.

The authors believe that, while an interval of three months may be desirable, it is possible to lengthen this period considerably and still improve the percentage of detection in early cases. Their data also suggest that the average growth and spread of gastric cancer are somewhat slower than previously believed.

In reviewing errors in interpretation, the authors emphasize the close resemblance of a small malignant lesion to a benign ulcer, a benign polyp, or even an anatomic variation. No new method of identifying small gastric cancers was discovered; the most careful and persistent application of the usual procedures is urged. Roentgenograms seem to be of special importance in the recognition of infiltrative areas, while fluoroscopy appears to be most helpful in the detection of the polypoid or bulky type of lesion.

Despite the demonstrated value of this type of routine roentgen examination, the problem of its application on a wide scale has by no means been solved. It is felt that at the present time this would be completely impractical.

Twenty roentgenograms; 1 graph; 1 table.

Roentgenologic Findings in the Stomach and Duodenum in Cancer of the Pancreas. Kaare A. Larsen and Arne Pedersen. Acta radiol. **45:** 459–469, June 1956. (Department of Roentgenology, Aker Sykehus, Oslo, Norway)

The authors made a retrospective examination of a five-year autopsy series of patients with carcinoma of the pancreas. A total of 50 cases were found, in 31 of which a barium contrast examination of the stomach and duodenum had been done. Eighteen of these showed positive signs for which the malignant condition of the pancreas might have been responsible.

The findings which, in the authors' opinion, have contributed to the diagnosis of cancer of the pancreas, are as follows: small, comparatively smooth impressions and defects (mucous membrane probably intact) in the bulb and upper duodenum or in the lower duodenum; defects with highly irregular mucous membrane relief (probably infiltration of mucous membrane) in the body and lumen of the stomach and duodenum; widened duodenal loop; displacement of the stomach and duodenum; constriction and dilatation of the duodenum; retractions with changes in mucous membrane relief; postbulbar impressions in the duodenum; "pad" sign in the pyloric antrum or in the duodenal bulb; calcification in the tumor. The most common sign found was the small, comparatively smooth impression defect in the bulb and the upper duodenum.

The authors conclude that the roentgenologic findings in the stomach and duodenum may be characteristic and give a clue to the diagnosis at an early stage.

Twelve roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

Arteriomesenteric Obstruction of the Duodenum in Adult Life and Adolescence. Erik de Fine Licht. Acta radiol. **45:** 441–451, June 1956. (Department of Radiology, Københavns Amtssygehus, Gentofte, Denmark)

There is a paucity of reports of arteriomesenteric obstruction in the adult and adolescent in the radiologic literature, although a relatively large number of patients undoubtedly suffer from this disorder. The milder forms, in which the clinical symptoms may be marked, but without abnormal disposition of the abdominal viscera, are of particular interest from the radiologist's point of view.

The roentgen changes consist in dilatation of the duodenum up to the duodenal-jejunal flexure with reversed peristalsis in the dilated portion, especially in the descending part of the duodenum, and with abnormally violent kneading of the intestinal contents in the region of dilatation. There may be some stasis, as the contents do not pass on at once but may remain in the duodenum for ten to twenty minutes or even longer. Although of rare occurrence, signs of gastric dilatation may occasionally be evident. In some patients these findings are present on repeated roentgen examinations; in others the occlusion is more intermittent.

Clinically the symptomatology is variable, with the exception of the pain pattern. In most patients pain develops after large meals and is relieved if the knee-elbow or prone position is assumed. Weight loss may be considerable because of anorexia as a result of the discomfort associated with ingestion of food.

It is generally accepted that there are two groups of patients with arteriomesenteric obstruction. The first group consists of patients with congenital disorders, whereas in the second group the condition is acquired. In many cases of the former group, the viscera may occupy a normal position, the obstruction being due to a mild malrotation in which the rotation as such has occurred in a normal way but fixation anomalies have arisen; it has been shown that such anomalies are often localized in the vicinity of the duodenum. In order to understand how this might ensue, a brief résumé of the process of intestinal rotation in the embyro and of the irregularities which may occur in its course is presented.

The acquired type of duodenal stenosis may be due to a variety of different causes such as duodenal ulcer, periduodenitis, pericholecystitis, perforating biliary calculi, carcinoma of the papilla of Vater or of the pancreas, retroperitoneal tumors, and other lesions. The radiographic findings, particularly in the presence of duodenal ulcer, may be similar to those observed in

the congenital form of arteriomesenteric obstruction. The differentiation between the two forms of the syndrome is facilitated to some extent by the fact that the duodenal bulb is slightly dilated in the congenital form and therefore fills readily and rapidly and appears to be normal.

A diagnosis of arteriomesenteric obstruction due to irregularities in normal intestinal rotation should be made only after repeated demonstration of the changes in the duodenum as described above and the exclusion of other conditions known to produce similar findings.

Four roentgenograms; 6 drawings; 1 table.

RITA M. BRADY, M.D.
University of California, S. F.

Spontaneous Renoduodenal Fistula. John Paul North, Shields O. Livingston, and B. K. Lovell. Surgery **39:** 683–687, April 1956. (VA Hospital, McKinney, Texas)

A case of spontaneous renoduodenal fistula resulting from nephrolithiasis and renal infection is added to the 16 cases found in the literature. The diagnosis was made roentgenographically in the course of a gastrointestinal series undertaken because of symptoms of duodenal obstruction. There had been no symptoms referable to the renal and perirenal disease.

Four hours after barium administration, a small amount of the medium could be seen extending to the right into an area where small lucent areas had been observed on the earlier film. On this basis the diagnosis was made. It was verified by exploration, which revealed two fistulas due to erosion of the duodenum by renal calculi.

Two roentgenograms; 1 drawing.

Intestinal Obstruction from the Radiological Point of View. Everett L. Pirkey and Dale Undem. J. Kentucky State M. A. **54:** 499–503, June 1956. (E. L. P., Louisville General Hospital, Louisville, Ky.)

The authors outline some of the radiologic procedures which are of aid in the evaluation of intestinal obstruction. Once the clinical diagnosis is established, the first roentgen method to be applied is plain radiography of the abdomen for study of the pattern and distribution of the intestinal gases and determination of the presence or absence of masses and abnormal solid viscera. Barium-enema studies are of considerable value when some form of colon disease is indicated as the precipitating factor; it is advised that in the performance of this procedure a small amount of opaque material be allowed to pass through the narrowed lumen, if possible, in order to ascertain the extent of the obstruction. By studying the mucosal changes in this area, a definitive diagnosis of such conditions as intussusception of the colon, carcinoma, diverticulitis, or volvulus can often be made. If the colon is eliminated as the site of obstruction, intestinal intubation is suggested as a possible diagnostic procedure; once the tube is thought to have reached the point of obstruction, an opaque material may be injected through the open lumen of the tube into the intestine under fluoroscopic control. During this procedure films may be obtained which show the site and type of obstruction. Five cases are presented.

Five roentgenograms; 1 diagram.

Studies in the Recognition of Strangulating Intestinal Obstructions with Special Reference to the Value of Pneumoperitoneography. John F. Perry, Jr., Stanley C. VonDrashek, and Owen H. Wangensteen. Surgery **39:** 725–735, May 1956. (University of Minnesota Medical School, Minneapolis, Minn.)

Attempts were made to demonstrate the presence of strangulated intestinal loops in experimental animals by several methods. The procedures included aortography, roentgenography following the intravenous injection of an opaque medium, introduction of radioisotope-tagged red blood cells, and pneumoperitoneography. Of these, pneumoperitoneography was found to be the most successful. Closed loop obstructions were most clearly shown; simple venous infarctions were less well visualized, and arterial infarctions could not be differentiated from a normal intestine.

The experimental results with pneumoperitoneography led to its clinical application in a number of cases. The authors mention some possible dangers attendant upon the procedure but consider it to be relatively safe. Its use is considered warranted in all instances in which the diagnosis of strangulation is inconclusive.

Histories of 3 patients with strangulating obstructions due to volvulus of the small bowel are given. In each instance, the strangulated intestinal segment was clearly demonstrated.

Thirteen roentgenograms; 1 photograph; 4 drawings; 1 table.

Cholecystography and Cholangiography: A Review of Present Methods of Examination. Noel H. Aldridge. Am. J. M. Sc. **231:** 701–721, June 1956. (Department of Radiology, The Johns Hopkins Hospital, Baltimore 5, Md.)

Under the general heading "Progress of Medical Science," the author reviews the pertinent contributions to the literature on cholecystography and cholangiography since 1943. Emphasis is placed on the various technics for examining the biliary tract, rather than the pathological implications.

A bibliography of 192 references is appended.

Cholecystographic Visualization of the Rokitansky-Aschoff Sinuses: Report of a Case and Review of the Literature. Robert D. Waller and S. M. Roberts. South. M. J. **49:** 221–225, March 1956. (VA Hospital, Augusta, Ga.)

The term Rokitansky-Aschoff sinuses is applied to the outpouchings or herniations of the mucosa into and through the muscularis of the gallbladder. Some of these communicate with the lumen by epithelial-lined ducts, others have large openings, and some have no communication. The roentgen diagnosis of Rokitansky-Aschoff sinuses is somewhat rare, since they are found only in diseased gallbladders, which usually are unable to concentrate the contrast medium. Sixteen roentgenographically demonstrated cases were found in the literature, and the authors present 1 of their own. [To these should be added 2 more examples reported by Ross *et al.* (Radiology **64:** 366, 1955) and 1 by Sutton (Brit. J. Radiol. **28:** 264, 1955. Abst. in Radiology **66:** 466, 1956).—Ed.]

The cholecystograms in the authors' case did not reveal the concentric ring of contrast medium just outside the lumen of the gallbladder commonly observed in Rokitansky-Aschoff sinuses. There were multiple areas of increased density which apparently were outlined by the diverticular projections into the wall, giving the gallbladder the so-called "mulberry" appear-

ance, which is believed to be an additional roentgenographic sign. There was also a constriction near the gallbladder neck, probably the result of chronic inflammatory changes.

One roentgenogram; 1 photograph; 1 table.

Cholegraphic Signs of Acute Biliary Stasis. Georg Theander. Acta radiol. **45:** 438–440, June 1956. (Roentgen Department, Malmö Allmänna Sjukhus, University of Lund, Lund, Sweden)

The author reports 2 cases in which intermittent biliary stasis was manifested by retarded contrast filling or non-filling of the biliary ducts during colic. An analogy is drawn between the signs of biliary stasis and those of urinary stasis, in which there is delay in the excretion of contrast material by the kidney. In the latter, however, the rate of excretion may be evaluated by comparison of the two organs, whereas in cholegraphy a single organ is involved and the diagnosis can be made only by comparing the observations in the course of an attack with those obtained during remission. In order to make such a comparison, immediate radiological consultation must be available so that, should a patient experience a spontaneous attack, an examination can be performed at once.

Three roentgenograms. RITA M. BRADY, M.D.
University of California, S. F.

Acute Pneumocholecystitis. A Review of the Literature and a Report of One Case. Edward G. LaCour and Lawrence J. O'Neil. Surgery **39:** 813–820, May 1956. (Charity Hospital of Louisiana, New Orleans, La.)

The authors base their discussion of acute pneumocholecystitis on a group of 37 cases collected from the literature and on 1 case of their own. The information derived from this series is tabulated, especially as to treatment and etiology.

Roentgen examination of the abdomen is necessary to establish the diagnosis of pneumocholecystitis preoperatively and should be undertaken in all apparent cases of acute cholecystitis. A flat film of the abdomen reveals a large globular gas-filled gallbladder, which, with the addition of a fluid level, may be seen also in the erect position. While these findings may not always be clear within the first twenty-four hours following onset of illness, they should be evident within forty-eight hours.

Two roentgenograms; 1 table.

Teaching Aids For Instruction in Radiologic Study of the Gastrointestinal Tract. H. R. Osheroff. South. M. J. **49:** 135–137, February 1956. (U. S. Army Hospital, Camp Gordon, Ga.)

A technic for teaching the changes in the contours of the gastrointestinal tract is described, which involves the use of an artificial rather than a genuine gross pathologic specimen for correlation with x-ray findings. Difficulty of handling and changes resulting from deterioration are given as disadvantages of an actual specimen.

The author's materials include Pyrex test tubes, 1 inch in diameter, and paraffin of the type used in the pathologic laboratory. The paraffin is heated and poured into the test tube; once it has cooled, depressions can be shaped with a hot pointed instrument to simulate an ulcer; paraffin may be added in localized areas to represent tumors; hot water may be poured in and out, removing sufficient paraffin to produce the effect of multiple ulceration. When the desired specimen is created, the test tube is filled with barium and a film is taken; following removal of the barium, the films can be readily compared with the specimen.

Seven roentgenograms; 1 photograph.

THE MUSCULOSKELETAL SYSTEM

Skeletal Metastases in Cancer of the Breast. Charles J. Staley. Surg., Gynec. & Obst. **102:** 683–688, June 1956. (VA Hospital, Chicago 11, Ill.)

The author reviewed 166 cases of cancer of the female breast (Ellis Fischel State Cancer Hospital) with skeletal metastases in an attempt to elicit the factors related to the occurrence of bone deposits in this disease. Fifty-five of these patients had undergone radical mastectomy at the same institution; the others had either been treated elsewhere initially or showed clinical evidence of widespread disease when first seen. The frequency and location of bone metastases were extremely variable, depending on such factors as the diligence of the search and the choice of sites to be examined roentgenographically. The ribs, pelvis, lumbar vertebrae, femur, thoracic vertebrae, and skull, in decreasing order of frequency, were most commonly involved.

The interval between operation and x-ray evidence of bone lesions was 19.8 months. In 96 per cent of the series skeletal metastases developed within five years. Sixteen patients were still alive at the time of the report, but none had survived for as long as five years. The average period of survival after discovery of bone metastases for those who had died was 10.7 months.

This study suggests that bone metastases are more likely to occur in the younger age group, but the reasons for this are not clear. Their development seemed to bear no clear relationship to the site of the primary breast lesion. It was found that control of the local disease (primary lesion and the regional node-bearing areas) had not been attempted, or had failed, in 79 per cent of those patients who later had demonstrable skeletal metastases. Of 55 patients who underwent radical mastectomy, with later bone involvement, at least 49 (perhaps all) had histologic proof of local metastases at the time of the operation.

It was interesting to note that pulmonary metastases were demonstrated in only 33 per cent of these patients, and in none did visualization of the lung lesions antedate the finding of bone involvement. In 24 per cent of the patients who underwent radical mastectomy, demonstrable skeletal metastases developed within six months, suggesting that, in some at least, the bone lesions were present at the time of the operation. These findings indicate the advisability of obtaining bone surveys preoperatively, especially in cases of borderline operability.

Ten tables. RICHARD E. ERNST, M.D.
University of Pennsylvania

Juxtacortical Chondroma. Henry L. Jaffe. Bull. Hosp. Joint. Dis. **17:** 20–29, April 1956. (Hospital for Joint Diseases, New York 35, N. Y.)

The author gives the name juxtacortical chondroma to an uncommon, benign, slow-growing tumor of cartilage cells arising in relation to the periosteum or immediate parosteal connective tissue. In the latter in-

stance the lesion probably develops by metaplasia from tendinous or ligamentous insertions in bone. In the 9 cases covered by this report the lesion was oriented to the shaft cortex of either a short or long tubular bone. In 7 cases the tumor was solitary; in 2 multiple foci were observed. Pain may be absent or of a dull aching character.

The x-ray appearance varies, depending on the stage of the mass. A faint, soft-tissue shadow 1 to 2 cm. in length overlying a shallow, sclerotic, cortical indentation may be the only finding. When the changes are more marked, the indentation of the cortex will be deeper but always a zone of sclerotic bone will separate the cartilage from the medullary cavity. A triangular wedge of periosteal new bone may be visible at the margin of the growth, particularly at the proximal end. The cartilaginous soft-tissue mass, which may or may not extend beyond the limits of the cortical defect, may contain foci of calcification or ossification, an important sign in the x-ray diagnosis of this lesion. Occasionally the non-cortical surface of the chondroma may be outlined in part or completely by a margin of calcification which has developed by metaplasia.

Several entities may give a similar x-ray appearance. In a long bone of a normal child a small metaphyseal area of cortical erosion, with or without a visible overlying soft-tissue mass, is far more likely to be due to a fibrous cortical defect than to a juxtacortical chondroma. In an adult the same appearance may be due to juxtacortical chondroma, since the ephemeral fibrous cortical dysplasia has usually disappeared by the age of ten. Histologically the fibrous lesions consist not of cartilage but rather of whorling bundles of fibrous connective tissue often containing multinucleated, giant cells. A pigmented villonodular tenosynovial lesion will occasionally occur, producing pressure erosion of the cortex of the neighboring phalanx of a toe or finger. This may appear as a lobulated soft-tissue mass on the film but will not show the focal or encircling calcification likely to occur in the chondroma. Rarely, a nonspecific tenosynovitis or even a ganglion may produce a similar x-ray picture. Neurofibromatosis may result in juxtacortical bone erosion but here the patient usually presents skin pigmentation, cutaneous nodules, and thickening of peripheral nerves.

Treatment consists in surgical extirpation of the cartilaginous mass, with its overlying fibrous mantle, and curettage of the eroded bone cortex.

Eight roentgenograms; 3 photomicrographs.

SAUL SCHEFF, M.D.
Boston, Mass.

Tumor of Bone of Vascular Origin. Anatomical-Radiological Considerations of Primary Hemangioma of the Skull. Giovanni Baldini and Luigi Ferri. Radiol. med. (Milan) **42:** 561–581, June 1956. (In Italian) (Istituto di Radiologia Medica e Terapia Fisica della Università di Pavia, Pavia, Italy)

Although hemangioma represents a fairly common neoplasm, the occurrence of benign vascular tumors within bone is rather unusual, at least in the sense of lesions demonstrable clinically or roentgenographically. Two-thirds of the skeletal hemangiomas are found in the skull or in the spinal column. The authors present 3 new cases (2 in males) of hemangioma of the skull and a fourth case of the same tumor originating in the soft tissues adjacent to the calvarium and secondarily involving the bone. The pertinent signs and symptoms are reviewed and etiological factors briefly discussed.

Hemangiomas of the skull are more frequent in women and are more commonly observed in the fourth decade of life. The authors believe that the violent migraine, often present, becomes more severe during the premenstrual period. The parietal bones are most commonly affected (about half of the cases culled from the literature); these bones contain abundant diploë in which the vascular lesions may develop. Both capillary and cavernous types of hemangioma have been observed. The x-ray appearance is characteristic. There is a circumscribed, round or oval, honeycombed area of rarefaction, tending to bulge the outer table. In tangential views the so-called "sunray" appearance is noted. This picture is produced by fine spicules of reactive new bone radiating from the center of the lesion; the striations do not have the parallel orientation which is found in the calvarium when this bone is eroded by contiguous extraskeletal tumors (as meningioma). Encephalography is noncontributory.

A detailed table summarizing the points in the differential diagnosis of focal osteolytic lesions of the skull is presented.

Sixteen roentgenograms; 2 photomicrographs; 1 table.

R. G. OLIVETTI, M.D.
Newington, Conn.

Infantile Cortical Hyperostosis. Fred Brooksaler and J. E. Miller. J. Pediat. **48:** 739–753, June 1956. (Southwestern Medical College of the University of Texas, Dallas, Texas)

Eleven cases of infantile cortical hyperostosis observed during a six-year period are reported. The patients ranged in age from two and one-half months to six months on admission; 7 were white, 4 were Negroes. The authors point out that the condition is not uncommon and should be suspected in every infant with fever, leukocytosis, hyperirritability, and swelling of the soft tissues. The diagnosis is established by x-ray studies of the underlying bones.

Although the mandible is not involved in all instances of the disease, as was originally believed, when it is affected, swelling over the jaws is observed, presenting a typical moon-shaped appearance. Other areas of swelling include the extremities and the ribs. One bone or several may be affected. The degree of swelling varies markedly with the progression of the disease through exacerbations and remissions.

Although complete roentgen studies were not undertaken in all cases of the present series, the distribution of bone involvement is given as follows: mandible, 8 cases; humerus, 4 cases; ulna, 4 cases; ribs, 4 cases; clavicle, 4 cases; femur, 2 cases; scapula, 2 cases (bilateral involvement); radius, 2 cases; tibia, 2 cases; fibula, 2 cases; metatarsals, 1 case; metacarpals, 1 case.

To be considered in the differential diagnosis are syphilitic periostitis, hypervitaminosis A, trauma, scurvy, and malignant neoplasm of bone. The clinical picture, laboratory findings, etiology, therapy, and prognosis are discussed and the literature is reviewed.

Twelve roentgenograms; 1 photograph; 1 table.

Fractures of the Spine in Children. Otto Lehmann. Bull. Hosp. Joint. Dis. **17:** 70–78, April 1956. (263 Bath Ave., Long Branch, N. J.)

The author reports 8 cases of fracture of the spine in

children from five and a half to twelve and a half years of age. Two of the group were known to have osteogenesis imperfecta. In each of these the fracture responded well to conventional treatment, with restoration of contour of the involved vertebra in spite of collapse of other vertebrae with progress of the disease.

The striking feature of the 6 cases without underlying disease was the relative absence of subjective complaints, as well as of major objective findings, following the moderate to severe flexion injuries. The complaints were mild to minimal and ephemeral. The physical findings consisted merely of some tenderness over the involved area with an occasional suggestion of kyphosis. Thus, even the indication for roentgenographic examination was questionable.

Nevertheless, conventional views of the spine, in some instances supplemented by laminagraphy, revealed anterior wedging of the bodies, usually thoracic in location. Multiple compressions of vertebrae, not necessarily adjacent, were observed, along with compression of the upper vertebral plate. The trabecular pattern of the body remained largely undisturbed, as did the posterior portion of the involved arches. Compression of bodies not discernible on the original examination but demonstrated by subsequent laminagraphy probably represented originally unrecognized compression rather than late, additional wedging. In some instances, however, there was increased wedging along with the development of scoliosis.

The final outcome seemed to depend little on the method of therapy, whether this consisted of active orthopedic measures or merely exercises and a hard bed. The significance of these injuries in relation to round back, Kümmell's disease, adult vertebral wedging, and scoliosis is speculative, but there would appear to be more than a coincidental relationship.

Nine roentgenograms. SAUL SCHEFF, M.D.
Boston, Mass.

Non-Specific Spondylitis in Children. H. Wissler. Schweiz. med. Wchnschr. **86:** 705–707, June 16, 1956. (In German) (Kindersanatorium Pro Juventute, Davos, Switzerland)

Non-specific spondylitis in children (most often of unknown etiology, seldom following an infectious disease) is today of equal or even greater importance than tuberculous spondylitis. The symptomatology in the two conditions is about the same, with limitation of motion, tenderness on percussion over the affected area, and backache, at times radiating toward the abdomen. A specific origin is favored by knowledge of tuberculous contact, a history of pleuritis or other condition compatible with a past primary infection, a positive Mantoux test, and roentgenographically demonstrable calcifications in the hili and/or abdomen. A definitely negative tuberculin skin test rules out acid-fast etiology.

The roentgenographic study of the spine is helpful but requires clinical correlation for final interpretation. Narrowed interspaces with adjacent, small or medium-sized cortical defects may be found in either type of spondylitis. Extensive bone destruction, involving more than one vertebral body, suggests tuberculosis. The osteoporosis, so characteristic of acid-fast processes, takes time to develop, and may be absent in the beginning. Repair processes occur more rapidly in non-specific spondylitis, with osteosclerosis and secondary osteoarthritic changes (lipping). Body-section roentgenography adds little to the diagnosis, but is of help in evaluating the progress of cases under treatment.

Early diagnosis is of utmost importance, since antibiotic therapy, adapted if possible to the causative microorganism(s), can prevent disabling sequelae. Three personal cases are included in the report.

Four roentgenograms. FRANZ GAMPL, M.D.
Cook County Hospital, Chicago

Treatment of Low-Back and Sciatic Pain by the Injection of Hydrocortisone into Degenerated Intervertebral Discs. Henry L. Feffer. J. Bone & Joint Surg. **38-A:** 585–590, June 1956. (George Washington University School of Medicine, Washington, D. C.)

Degeneration of the intervertebral disk is an insidious process and may long exist in a quiescent state. Surgical exploration at the time of a flare-up into an acute phase usually demonstrates a swollen, bulging, soft disk, with the posterior annulus frequently found to be intact. It would seem, therefore, that these degenerative changes should often be reversible.

The local anti-inflammatory action of hydrocortisone in reversing or blocking the inflammatory process in degenerative joint disease is well known. It would seem, then, that this preparation should have a beneficial effect when injected into the acutely swollen intervertebral disk if the process has not become irreversible.

Hydrocortisone was injected successfully into one or more intervertebral disks (usually the fourth and fifth lumbar) in 60 patients. Combined with the hydrocortisone was an iodopyracet solution, so that a nucleogram could be obtained at the same time (see Erlacher: J. Bone & Joint Surg. **34-B:** 204, 1952. Abst. in Radiology **60:** 463, 1953). In 5 of the 60 patients normal nucleograms were obtained and none of this small group showed any improvement. Of 55 patients with disk lesions, 37 (67 per cent) experienced a rapid remission of symptoms. Relief was usually evident in four to six hours. These remissions were maintained in 33 of these 37 patients followed for eight months. In 18 (33 per cent) patients, there was no response. Sixteen of these were subsequently explored and gross irreversible herniations were found in 15.

Two roentgenograms; 3 charts.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Fractures and Pseudarthroses of the First Rib. J. S. Dunbar. J. Canad. A. Radiologists **7:** 14–17, June 1956. (1615 Cedar Ave., Montreal 25, Quebec, Canada)

Report is made of 3 cases of fracture of the first rib. In 2 instances there was no history of direct trauma, while the third patient had suffered chest injury in an automobile accident. All 3 of the fractures failed to show bony union over a follow-up period of some years. For each of the reported cases earlier films showing intact ribs were available, thus ruling out the entity "congenital pseudarthrosis" of the first rib.

A review of the literature shows that fractures of the first rib are more common than usually thought. Injuries most frequently occur in the mid part of the rib near the crossing point of the subclavian artery. For some reason, fractures here show a strong tendency toward non-union. Well documented cases of indirect trauma or "fatigue fracture" as a mechanism of injury are now known. The age group involved (nineteen to twenty-five years) corresponds to that for "fatigue

fractures" in other bones. Most cases are found in individuals who lift or carry heavy objects on their shoulders.

Seven roentgenograms. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Diagnostic and Therapeutic Obstacles Encountered in Tibial Plateau Fractures. Julius S. Neviaser and Sanford H. Eisenberg. Bull. Hosp. Joint Dis. **17:** 48–57, April 1956. (1918 K St., N. W., Washington 6, D. C.)

Tibial plateau fractures, known also as "bumper" or "fender" fractures, frequently result from a valgus or varus strain at the knee joint, which usually takes the form of direct violence to the inner or outer side of the extended knee. Less commonly the injury is the result of indirect force, as in a fall from a height in which the foot strikes the ground, transmitting the force upward, driving the tibia against the femoral condyle.

Routine roentgenographic study in these cases has proved disappointing and sometimes misleading, since not only do the conventional views fail to reveal the soft-tissue damage but usually do not demonstrate the full measure of bone injury. Since only the posterior half of the articulating tibial surface is commonly depressed by the injury, the anteroposterior and lateral views make complete evaluation difficult. The authors employ, in addition, the so-called open-notch or tunnel view and an oblique projection of the joint to show the extent of the depression of the tibial plateau, and arthrograms to demonstrate tears, if any, in the joint capsule.

The paper stresses the need for surgical treatment of tibial plateau fractures in order to correct the soft-tissue damage, such as tearing of a meniscus; to elevate depressed fragments of the articular cartilage; and to suture tears of the joint capsule. Surgery also affords the opportunity of filling in the cavity formed in the underlying spongiosa by the depressed articular surface with a cortical bone graft taken from the tibia or femur at the time of operation. The graft adds support to the re-established joint surface.

Thirteen roentgenograms; 5 photographs.
SAUL SCHEFF, M.D.
Boston, Mass.

Non-Suppurative Osteitis Pubis in the Female. Leon L. Wiltse and Charles H. Frantz. J. Bone & Joint Surg. **38-A:** 500–516, June 1956. (L. L. W., 117 E. 8th St., Long Beach 13, Calif.)

The authors report 13 cases of a disease in women, involving the anterior pelvic girdle, which they believe is a clinical entity related to osteitis pubis observed so frequently in men. As seen in these patients, the process was non-suppurative and non-inflammatory. In 5 of the women the symptoms were first noted during pregnancy, and in 5 others they appeared within two months after delivery. In 2 cases, symptoms developed after an injury, and in the remaining patient they followed extensive pelvic surgery.

The initial complaint in each instance was pain over the symphysis. Tenderness was present on palpation. There was no soft-tissue swelling. Fever was absent or of low grade.

Roentgenograms made at the onset of the disease will usually show no abnormalities in the symphysis other than instability in some patients. This instability can be demonstrated by obtaining roentgenograms of the symphysis with the patient bearing weight on one and then on the other lower extremity. Later in the disease, a spotty demineralization will appear in the bone adjacent to the symphysis, associated with some widening of the symphysial gap. Still later, sclerosis appears in the bone adjacent to the symphysis and the symphysial space is narrowed. The osseous changes never extend more than a few centimeters lateral to the symphysis and are bilaterally symmetrical.

The specific etiology of the disease is not known. The authors' concept is that it is a localized reflex neurovascular dystrophy brought about by a combination of trauma and predisposing changes at the symphysis. The changes at the symphysis are due to the influence of certain hormones and are of the nature of but more pronounced than those which normally occur during pregnancy.

The disease is self-limited, with gradual symptomatic recovery taking place in a period varying from a few weeks to three and one-half years.

Nineteen roentgenograms; 2 photomicrographs; 2 tables. DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Osteoid Osteoma of the Ischium with Hip Joint Complications. F. G. Stuart. J. Canad. A. Radiologists **7:** 21–24, June 1956. (841 Collinson St., Victoria, B. C., Canada)

A 10-year-old girl was admitted for hospital study with a six-month history of pain in and around the right hip, aggravated by walking. Roentgenograms showed a vague, slightly increased density in the right ischium, with a poorly defined central translucent zone about 1 cm. in diameter. Mild osteoporosis was visualized in the proximal end of the right femur.

Conservative therapy was instituted, but after ten months the patient still complained of pain and there was limitation of motion in the right hip. Sclerosis had gradually increased in the ischium adjacent to the acetabulum, and disuse atrophy in the proximal femur. A radical approach was now decided upon, some sixteen months after the onset of the hip pain. Partial excision of the right ischium and curettement of the medullary canal surrounding the ischial portion of the acetabular wall yielded tissue diagnosed as "osteoid osteoma."

Following operation, pain disappeared dramatically. Over the next year, however, a progressive degenerative arthritis developed in the hip joint characterized by cyst-like changes in the subchondral cortices, joint space narrowing, and variations in bone density and cartilage thickness. It was then decided to put a vitallium prosthesis in the joint. The patient did reasonably well but continued to experience some pain in the hip. The osteoid osteoma evidently did not recur.

The author emphasizes the damage to joints, particularly the hip joint, arising from adjacent osteoid osteoma. He enters a plea for early diagnosis and surgical treatment of this benign bone tumor before irreversible joint changes can develop.

Three roentgenograms. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Naviculo-Capitate Fracture Syndrome. Richard L. Fenton. J. Bone & Joint Surg. **38-A:** 681–684, June 1956. (960 Park Ave., New York 28, N. Y.)

When the hand is outstretched in a position of dorsiflexion and radial deviation during a fall, the pointed

radial styloid process impinges on the waist of the navicular and may function as a chisel in producing a fracture of the navicular. When the force of the blow is only moderately severe, the navicular alone will be fractured. However, when the blow is particularly violent, the force will be transmitted on through the proximal portion of the capitate, which will also be fractured. The fracture line in the capitate is a direct continuation of the fracture in the navicular.

The nature of the force in the capitate is such that it rotates the proximal fragment in the capitate through 180 degrees, resulting in apposition of the joint cartilage to the fractured surface. The proximal fragment in the capitate is without a blood supply after the injury, since the blood supply for the entire bone enters its distal surface.

The author presents 2 cases of this fracture syndrome and discusses the method of treatment.

Ten roentgenograms; 2 drawings.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

GYNECOLOGY AND OBSTETRICS

Hysterography in the Diagnosis of Dead and Retained Human Ovum. Juan C. Ahumada, Armando E. Nogués, and Cornelio Donovan. Am. J. Obst. & Gynec. **71:** 1274–1278, June 1956. (Catedra de Clinica Ginecologica de Buenos Aires, Buenos Aires, Argentina)

Several procedures for demonstration of death of the ovum *in utero* have been suggested. While simple roentgenography has proved useful in advanced pregnancy, the results before the fourth or fifth month are poor, and at this early stage clinical findings are insufficient for a definite diagnosis. Under these circumstances, the authors have found hysterography a useful procedure. They use 10 to 15 c.c. of an aqueous contrast medium. A preliminary Friedman test excludes the presence of a viable ovum.

The radiopaque image is characteristic: the outer limits in contact with the uterine wall are incomplete and festooned; the inner limits of the shadow resulting from contact of the dead ovum are irregular in outline. When the implantation site is in the fundus, the uterus takes on the shape of a fig, due to the fact that the cervical and isthmic portions are not involved in the total changes. With implantation on the lateral wall, the uterus assumes a rounded shape.

In a series of 13 cases the authors encountered no complications. In only 2 cases was an incorrect diagnosis made. Details of the series are presented in tabular form.

One roentgenogram.

ROBERT L. EGAN, M.D.
University of Texas, Houston

A Radiological Study of the Placental Stage of Labour. John Macpherson and John K. Wilson. J. Obst. & Gynaec. Brit. Emp. **63:** 321–330, June 1956. (Mill Road Maternity Hospital, Liverpool, England)

The authors report the results of a radiologic study of the placental stage of labor. The study was based upon 29 cases, including 4 cases of anencephaly, 24 cases of breech delivery, and 1 case in which the cord was injected after the second stage was complete. As soon as the cord became available, it was injected with 20 to 40 c.c. of 70 per cent Diodone. The injection was made, as a rule, into the umbilical vein, but the umbilical artery was entered in several cases. Four to twelve radiographs were taken in the anteroposterior projection.

Early signs of separation of the placenta observed in this series were: (1) changes in the relation of the placental shadow to the soft-tissue shadow of the uterus, in 9 cases; (2) descent of the lower border of the placenta, in 16 cases; (3) changes in relative filling of different parts of the placenta, in 13 cases; (4) crowding of the vessels, in 11 cases; (5) divergence of vessels, in 7 cases. None of these signs, however, can be accepted without qualification as reliable evidence of placental separation. Alterations in the curvature of the small vessels, described by Burton-Brown as evidence of separation (J. Obst. & Gynaec. Brit. Emp. **56:** 847, 1949. Abst. in Radiology **55:** 306, 1950), were not observed in this series.

Of the late signs of placental separation the most convincing is descent of the placenta into the lower uterine segment and vagina. Except when the third stage of labor is clearly abnormal, this occurs very rapidly, within five minutes or less after the end of the second stage. Frequently it was observed before the after-coming head was extracted in breech delivery. Rapid separation and descent of the placenta were also observed when anencephalic fetuses were born head first.

Sixteen roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

Otto Pelvis. A Report of Two Cases Associated with Labour. W. H. Muller. J. Obst. & Gynaec. Brit. Emp. **63:** 385–389, June 1956. (Department of Obstetrics & Gynaecology, University of Cape Town, Cape Town, Union of South Africa)

The authors report 2 cases of labor in women with intrapelvic protrusion of the acetabula (the "Otto" pelvis). This pathologic state is defined as "an affection of the hip joint characterized anatomically by deepening of the acetabulum with mesial displacement of the inner wall."

The condition occurs at all ages, but is usually found in middle age. Roentgenologically, the head of the femur is typically intact and buried deeply in the acetabulum. The medial and inferior walls of the acetabulum are thinned and lead to a dome-shaped protrusion into the pelvic cavity. Motion is limited as a result of the deep placement of the femoral head and by osteophytes which often project outward at the junction of the head and neck.

By virtue of its disturbance of normal pelvic architecture, Otto pelvis may adversely affect the course of labor. Two cases are reported, in each of which prolonged labor occurred. Fetal death followed in one instance as a result of massive intracranial hemorrhage.

The author believes that with greater use of radiography in obstetrics, together with the knowledge that this abnormality may be found in the earlier age groups, an increase in the number of recorded cases may be expected.

Four roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

THE GENITOURINARY SYSTEM

Differential Diagnosis Between Cancer and Solitary Serous Cyst of the Kidney. B. G. Clarke, William J. Goade, Jr., Harold L. Rudy, and Lawrence Rockwood. J. Urol. **75:** 922–929, June 1956. (30 Bennet St., Boston 11, Mass.)

The purpose of this study was to evaluate preoperative criteria for the differentiation of tumors and cysts of the kidney, and to justify exploration and excision in the case of a renal mass which was more likely to be cystic than neoplastic.

The histories and roentgenograms of 83 patients were reviewed. Thirty-six of this number were found to have malignant tumors; of these, 34 were subjected to nephrectomy and 2 to exploration and biopsy. Forty-seven patients proved to have solitary serous cysts; of these, 39 had surgical excision while in 8 the diagnosis was proved by translumbar needle puncture.

The following factors were found to be of no value in the differential diagnosis: age or sex of patient, size and location of mass, its laterality, renal axis deviation, ureteral displacement.

Several clinical signs of presumptive but none of absolute diagnostic significance were discovered. The cysts were largely asymptomatic. Most of the cancers, on the other hand, exhibited one or more of the usual symptoms—a palpable mass, anemia, and occasionally fever. Of extrarenal roentgen abnormalities, changes in the psoas shadow were observed 7 times, always in association with cancer. Calcification within the mass was relatively common in cancer but was not observed in any of the cysts in this series, though it has been reported in a solitary cyst. Demonstration of a local mass protruding extrarenally was usually indicative of a cyst, though it did not exclude a diagnosis of cancer. Amputation of the calyces was seen in 25 per cent of the cancer cases but in only 2 per cent of the patients with cysts.

Retrograde pyelography was found to offer no special advantage over intravenous pyelography, provided a satisfactory pyelogram could be obtained. In poor operative risks, in whom pyelograms suggest a cyst rather than a tumor, the spherical, avascular nature of the lesion may be demonstrated by nephrotomography or aortography. Translumbar needle puncture may then be done with small risk of encountering cancer. The cystic character of the lesion is corroborated by injection of a water-miscible medium and by examination of the fluid.

Operative exploration in the case of a renal mass which is more likely to be a cyst than a tumor is justified on the following grounds: (*a*) cysts may cause pressure symptoms; (*b*) a cyst may destroy renal cortex by direct pressure or by ureteral obstruction leading to secondary hydronephrosis; (*c*) infection may occasionally occur within a cyst; (*d*) a solitary cyst may cause reversible hypertension of the Goldblatt-Page type; (*e*) a small cancer may occur within the wall of a typical serous cyst; (*f*) solitary cysts may undergo spontaneous rupture and cause serious hemorrhage.

Eight roentgenograms; 5 charts; 2 tables.

KUNDALA SUNDARAVEJ, M.D.
University of Pennsylvania

Renal Tubular Disease with Nephrocalcinosis. Report of Two Unusual Cases. J. A. James. J. Dis. Child. **91:** 601–605, June 1956. (5323 Hines Blvd.' Dallas 19, Texas)

Renal medullary calcification was first described in infants in 1935 and was correlated with a clinical syndrome including failure to thrive, constipation, and anorexia. The following year renal calcinosis was reported in association with dehydration and acidosis. Several other reports of infantile idiopathic renal acidosis have since appeared. Symptoms commonly start during the latter half of the first year and include vomiting, anorexia, constipation, and failure to gain weight. The urine commonly contains a trace of albumin and an increased number of white blood cells; the pH is alkaline or weakly acid in spite of systemic hyperchloremic acidosis. Renal medullary calcification is demonstrable radiographically in some cases.

The author reports 2 cases, 1 of which came to necropsy. In this latter case, in an infant of five months, calcification was found in the medulla, occasionally beginning in the basement membrane of the tubule. The cause of death was infection, dehydration, and thrombosis of the inferior mesenteric vein.

The second patient, a child of four, was seen with hypocalcemic tetany following a febrile illness. Nephrocalcinosis was demonstrable roentgenographically, with mild unilateral hydronephrosis. This could not, however, be attributed to hyperchloremic acidosis since the blood chloride was consistently normal. The author discusses the possible importance of endocrine as well as renal factors in the etiology.

One roentgenogram; 2 photomicrographs.

SAUL SCHEFF, M.D.
Boston, Mass.

Nephrocalcinosis in Patient with Duodenal Ulcer Disease. Report of a Case Associated with Parathyroid Adenoma. Robert Edgar Mitchell, Jr., C. Robert Tittle, and H. L. Bockus. Gastroenterology **30:** 943–949, June 1956. (H. L. B., 250 S. 18th St., Philadelphia 3, Penna.)

Diffuse nephrocalcinosis may be associated with chronic pyelonephritis, chronic glomerulonephritis, primary hyperparathyroidism, hyperchloremic acidosis, vitamin D intoxication, sarcoidosis, idiopathic hypercalcuria, and tuberculosis of bone. Another possibility is the prolonged ingestion of absorbable alkali and calcium, as in patients on a medical regime for peptic ulcer. Chronic hypercalcemia of this last type—the so-called milk-alkali syndrome—has many features in common with hyperparathyroidism. The calcification is usually finely granular, diffuse, and confined chiefly to the medullary portion of the kidneys.

A case is reported which demonstrates the difficulty of differential diagnosis in the presence of roentgen evidence of diffuse nephrocalcinosis, in this instance associated with chronic duodenal ulcer. The patient was placed on a low-calcium diet to rule out the possibility of a milk-alkali syndrome, and the evidence thus obtained, together with other clinical and laboratory findings, established a diagnosis of primary hyperparathyroidism, which was confirmed at operation.

One roentgenogram; 1 table.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

Urethrocystography in the Differential Diagnosis of Prostatic Cancer. K. J. Oravisto and S. Schauman. J. Urol. **75:** 995–999, June 1956. (Surgical and Roent-

genological Department of Maria Hospital, Helsinki, Finland)

The authors reviewed 77 cases of urethrocystography performed in the department of radiology of the Maria Hospital, Helsinki, during the years 1952–1954. In 16 of these, cancer of the prostate was proved histologically and in 4 on the basis of metastases. Benign prostatic hypertrophy was found in 16 cases, proved by prostatectomy or at autopsy. The diagnosis in the remaining 41 cases was not proved and these were therefore excluded from the study.

The technic consisted of filling the bladder with a thin contrast medium, after which a water-soluble contrast medium was injected into the urethra. Roentgenograms were made in the anteroposterior and oblique projections.

In addition to the typical saber-like posterior urethra of benign hypertrophy and the rigid tube deformity of the posterior urethra in carcinoma of the prostate, the following were found to be of value in the differential diagnosis: the shape of the bladder floor, the contour of the posterior urethra, its width, type of elongation, and its angulation.

In 11 (55 per cent) of the cancer patients, the impression of the prostate on the floor of the bladder presented an irregular contour that was felt to be due to multiple small nodules. This is in contrast to the smooth impression characteristic of benign hypertrophy. In only 2 of the benign group could the bladder floor be called irregular. The irregularity associated with carcinoma has not, on the other hand, the ragged appearance observed in inflammatory disease with ulceration.

The contours of the posterior urethra are practically always smooth in prostatic hypertrophy. Any raggedness of this area should suggest a malignant lesion. Recent intraurethral manipulation may, as a result of trauma, produce changes that closely resemble the ragged appearance of prostatic carcinoma.

Widening of the posterior urethra in the sagittal plane and an increase in its length were seen in both benign hypertrophy and carcinoma. Each finding was twice as common in the benign cases.

Stiffness of the posterior urethra (nearly uniform width throughout, narrow, often elongated and fairly straight) is "almost pathognomonic" of prostatic carcinoma. The saber-like shape (elongated, sagittally widened, and heavily curved posterior urethra), however, was not found in any one of the cancer group.

The authors present two roentgenologic syndromes which they consider "nearly pathognomonic" of prostatic carcinoma: (*a*) irregularity in both the floor of the bladder and the posterior urethra (seen in 50 per cent of carcinoma patients and not found in any instance of benign hypertrophy); (*b*) absence of angulation combined with an irregular bladder floor or posterior urethra. The latter was established in 70 per cent of carcinoma patients but not once in hypertrophy.

Five roentgenograms; 1 table.

JOHN HARRIS, JR., M.D.
University of Pennsylvania

A Simple Instrument for Urethrocystography and Fistulography in Adults and Children. Åke Gullmo. Acta radiol. **45:** 473–478, June 1956. (Roentgendiagnostic Department, University Hospital, Lund, Sweden)

The author describes a simple instrument for urethrocystography and fistulography in adults and children. This consists of a set of ordinary Record syringe cannulae, 1.0 to 1.2 mm. in diameter and 8 to 10 cm. in length, provided with terminal cones ranging in diameter from 2.5 to 11 mm. For a particular case, a cannula of such size as to fit firmly in the external urethral os is chosen. A rubber or plastic tube about half a meter long with a Record syringe fastened at one end permits the injection of contrast medium from behind a screen, protecting the examiner's hands against radiation during fluoroscopy. The tube is filled with the medium before it is connected to the cannula. Following injection of 10 to 15 c.c. a roentgenogram is made of the anterior urethra. A further 15 c.c. is then introduced and roentgenograms of the posterior urethra are obtained.

The examination is continued during urination (performed through the instrument) preferably with the patient lying down.

The instrument described has been found especially useful in examination of patients with hypospadias and other anatomic anomalies. In such cases, the urethral orifice is usually so small that the largest possible cannula of the series fits firmly without additional fixing. The cannulae may also be used for other purposes, such as fistulography.

Five roentgenograms; 1 photograph.

THEODORE E. KEATS, M.D.
University of Missouri

Intravenously Given Urographic Mediums. Comparative Study of Eight Hundred Cases. Walter Lentino, Bertram E. Zeitel, Harold G. Jacobson, and Maxwell H. Poppel. J.A.M.A. **161:** 606–609, June 16, 1956. (H. G. J., 210th St. and Bainbridge Ave., New York 67, N. Y.)

The authors report the results of a study of the four most commonly used intravenous urographic media. Eight hundred patients were divided into groups of 200, one group being given Neo-Iopax (50 per cent solution), one Urokon (50 per cent solution), one Hypaque (50 per cent solution), and one Renografin (76 per cent solution). Hypaque and Renografin were found to offer superior results in quality of visualization. The lowest incidence of reaction was encountered with Renografin, although this agent was somewhat more difficult to administer because of its high viscosity. The greatest number of reactions were produced by Urokon. Skin and ocular testing were of no value in predicting reactions. Intravenous testing should be done in allergic individuals but is probably of no help in the average patient. A significantly higher incidence of reaction to intravenous urographic media was encountered in persons with a history of allergy than in non-allergic patients.

Since Renografin and Hypaque are considered to be the media of choice, their use in individual cases should be based on the following considerations: (*a*) in cases where ease of administration is required, Hypaque should be employed; it should be realized, however, that this convenience is obtained at the risk of a higher incidence of reactions; (*b*) Renografin is the agent of choice in all instances where avoidance of reaction is the primary consideration, and is mandatory in persons who have sustained reactions in a previous procedure with an intravenous urographic medium or in patients with a history of allergy. Because of its high

viscosity, the use of Renografin requires that scrupulous technic be followed.

Four figures; 2 tables.

Excretory Urography with Hypaque Sodium. Experience with 300 Cases. Ernest Kraft and Gregory S. Slater. Connecticut State M. J. **20:** 437–440, June 1956. (E. K., VA Hospital, Northport, N. Y.)

The authors report their experience with Hypaque for excretory urography in 300 cases. Preparation of the patient included administration of castor oil the day before the examination, mild dehydration, and in some instances a cleansing enema. Iodine sensitivity and other allergies were investigated. A full dose of 30 c.c. was used for most adults. No severe reactions were encountered, and even lesser reactions were infrequent.

Films exposed one minute after completion of the injection frequently demonstrated a nephrogram effect and were of value in the study of renal contours and possible cysts and abnormal masses. By two minutes, considerable filling of the calyces and pelves had occurred. At three minutes, filling was optimal in 58 per cent of the cases. A delayed film at fifteen or twenty minutes in patients without a history of urinary block showed simultaneous filling of ureters and bladder. In cases with block optimal filling may require as long as twenty-four hours.

On the basis of these studies, the authors feel that an adequate routine includes a preliminary film and exposures at three minutes and fifteen minutes. Special views may be obtained if indicated on reading of the wet films.

The primary advantages of Hypaque include its low toxicity, more rapid appearance in the urinary tract, and maintenance of diagnostic densities over longer periods than with other media. In this series, good to excellent visualization was achieved in 93 per cent of the cases. The diagnostic quality of pyelograms obtained with 50 per cent Hypaque was about the same as with 70 per cent solutions of other preparations. The need for re-examination or retrograde study was considerably reduced.

Six roentgenograms. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Reactions Due to Intravenous Urokon. Vernon H. Youngblood, Jerome O. Williams, and Allan Tuggle. J. Urol. **75:** 1011–1015, June 1956. (Cabarrus Memorial Hospital, Concord, N. C.)

The authors believe that reactions to intravenous Urokon are more frequent than was originally thought. They report 2 cases.

The first patient was a sixty-year-old white male being studied for hematuria and a cystoscopically proved bladder tumor adjacent to a diverticulum. His allergic history was completely negative except for a "skin reaction" following sulfonamide treatment for a cellulitis of the hand more than twenty years earlier. One hour before the administration of the medium he received 50 mg. of Pyribenzamine orally. He was given 1 c.c. of 70 per cent Urokon intravenously, without reaction, and two minutes later the remainder was administered without any immediate complaints. Two or three minutes later, however, he was unconscious and cyanotic. An airway was established and oxygen was given, but death ensued twenty minutes after the first injection. Benadryl, Coramine, and adrenalin were used to no avail.

Autopsy revealed edema of the larynx and posterior nasopharynx. The entire trachea was filled with thick tenacious mucoid material. There was no family history of allergy, and during his life the patient had used tincture of iodine topically with impunity.

The second patient was a sixty-six-year-old man admitted to the hospital for a transurethral resection. He gave a history of "some type of reaction to an anesthesia" for cholecystectomy some years earlier; his personal and family history were negative for allergy. A skin test with Urokon was interpreted as negative, and 24 c.c. of a 50 per cent concentration of the drug was given slowly intravenously. Three minutes later the patient complained of a peculiar taste in his mouth, followed by flushing of the face and a desire to vomit. He began to froth at the mouth, convulsions occurred, and cyanosis and apnea developed. Artificial respiration, adrenalin, and Chlor-Trimeton were administered immediately, and four minutes later consciousness returned. The patient was well the next day except for myalgia.

With 70 per cent Urokon the authors did not find the incidence of flushing of the face, nausea, and fullness in the chest any higher than with other contrast media, but they did observe an increased tendency to thrombosis of the arm veins.

Subsequent to these unfortunate reactions, the authors have kept an emergency kit on hand, consisting of a tank of oxygen with a mask and bag, intravenous and intramuscular hydrocortisone, intravenous Benadryl, throat gag, tongue forceps, and suction apparatus. In addition, 0.5 c.c. of 1:100 adrenalin and 10 mg. of Chlor-Trimeton are drawn up in syringes and kept at hand during the examination.

FREDERICK J. MUNSON, M.D.
University of Pennsylvania

The Effect of Intravenous Benadryl in Allaying Allergic Manifestations of 70 Per Cent Urokon. Jack Lapides and Robert E. Boyd. J. Urol. **75:** 1016–1018, June 1956. (Wayne County General Hospital, Eloise, Mich.)

The authors present data obtained from the records of 1,281 patients injected intravenously with 50 mg. of Benadryl prior to injection of 70 per cent Urokon. They report no cases of major reaction such as urticaria, laryngospasm, asthma, or shock, and compare this result to a reported incidence of 1.67 to 3.49 per cent of such reactions in patients not receiving this preliminary medication. The incidence of nausea, vomiting, flushing, and arm pain was not decreased. It is suggested that the former reactions represent allergic manifestations to the contrast medium, while the latter group do not. However, the addendum notes that the 1,500th patient, seen after completion of the study, did exhibit urticaria and bronchospasm.

Two tables. L. MURRAY HOUSER, II, M.D.
University of Pennsylvania

MISCELLANEOUS

Trauma to the Abdominal and Retroperitoneal Viscera as it Concerns the Radiologist. J. Cash King. South. M. J. **49:** 109–119, February 1956. (University of Tennessee College of Medicine, Memphis, Tenn.)

This discussion of the radiological aspects of trauma to the abdominal and retroperitoneal viscera is based on a series of 61 cases seen from January 1946 through

July 1955, representing an incidence of 1 in 2,090 admissions. Reports of 13 cases are given, including 4 (6.5 per cent) which terminated fatally. It is pointed out that visceral injury from non-penetrating trauma, while relatively rare (as indicated by the above figure), is not precluded by the absence of shock or internal bleeding.

The following outline is offered to guide the radiologist in the study of trauma to the mid-trunk region:

1. Skeletal injuries.
2. Changes in size or contour of the affected organ: (*a*) enlargement; (*b*) deformity; (*c*) loss of sharp delineation.
3. Evidence of bleeding into an adjacent space (peritoneal cavity or retroperitoneal space): (*a*) displacement of adjacent visceral structures; (*b*) homogeneous density adjacent to the affected organ; (*c*) accumulations of fluid between gas-filled intestinal loops; (*d*) increased overall density (peritoneal cavity or retroperitoneal space); (*e*) fluid adjacent to extraperitoneal fat layer in flank.
4. Changes in other organs: (*a*) altered position, contour, or movement of the diaphragm; (*b*) ileus or other gaseous distention of the gastrointestinal tract.

For minimal x-ray examination, the author recommends films of the chest, preferably in the upright and supine positions, and of the abdomen, in the supine and either upright or lateral decubitus positions.

Ten roentgenograms.

TECHNIC

The Technic of Simultaneous Telefilmplanigraphy. Vidar Backlund. Acta radiol. suppl. 137, 1956. (In German) (Zentralen Röntgenklinik des Krankenhauses St. Göran, Stockholm, Sweden)

Single-film planigraphy has become an accepted procedure but it has four distinct disadvantages: inexact co-ordination in parts which cannot be held absolutely still, excessive consumption of time, high radiation dosage to the patient, and wear and tear on the tube due to the rapidly repeated exposures. Multiple-film planigraphy overcomes these shortcomings and, in addition, provides material for a three-dimensional reconstruction.

Multiple-film planigraphy was first proposed in 1932. In 1947 de Abreu produced three to five planigrams but the quality of these was inferior. The present author believes that he has solved most of the problems that have prevented successful application of the method up to the present time.

The problem of scatter radiation is handled with the distance technic of Groedel and Laurell. In this system the distance from the object to the film is increased. If a small film is used, this cuts down scatter because most of the scatter will fall outside of the film area. Experimentally, 15 cm. was determined as the optimum object-film distance. Beyond 15 cm. the unsharpness and the magnification interfere with proper interpretation. This use of a long object-film distance will be immediately recognized as the same as van der Plaats' enlargement technic for primary magnification (J. belge de radiol. **32**: 89, 1950). Since magnification is not an object in planigraphy, and in order to conserve sharpness, it is recommended that with the object-film distance kept at 15 cm., the focal spot-object distance be rather large and the focal spot itself small. It is suggested that an object 20 cm. thick be radiographed at 2 meters with a 2-mm. focal spot.

With telefilm technic, the selectivity is stated as the order of an 8-1 grid. Films can be made at any angle, and any part of the body can be examined. If desired, a 15-1 grid can still be used with allowance for the longer exposure time.

In order to obtain multiple exposures simultaneously, a folder type of holder for the films has been designed, with specially constructed intensifying screens of graduated filtration (prepared by the CEA Corporation of Sweden). Double-emulsion films with a single intensifying screen are used. Sheets of tinfoil separating the compartments of the holder filters cut out the K radiation of tungsten. A total of eleven layers can be radiographed simultaneously.

With films taken in the 100 to 120-kvp range, with exposure times of one to one and a half seconds, the patient receives a maximum of 2.94 r to the skin, based on direct measurement. In most instances, the skin dose is far less, on the order of 0.1 to 0.5 r.

The technical description of this procedure as outlined by the author is quite impressive. The planigrams, on the other hand, which illustrate the last third of the book, are certainly not comparable in quality with the single-film planigraph as ordinarily obtained.

Fifty figures, including roentgenograms, graphs, and photographs; 12 tables.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

The Improvement of Definition by X-ray Image Magnification. A. Nemet and W. F. Cox. Brit. J. Radiol. **29**: 335–337, June 1956. (Philips Balham Works Ltd., London, S. W. 12, England)

The authors show mathematically and graphically that improvement of definition by x-ray image magnification can be produced by reducing the size of the focal spot. They state that the blurring due to film and/or screen is constant and not affected by magnification as is the geometric blurring, which is directly proportional to the focal spot size and magnification of the image. It is shown that the effective blurring is inversely proportional to the magnification up to the point where the geometric blurring equals the screen blurring.

Other effects which must be considered are the increased patient dose and smaller area of the patient examined on a given film size.

Two graphs.

HAROLD LANGSTON, M.D.
University of Arkansas

RADIOTHERAPY

The Treatment of Cancer of the Thyroid Gland. L. Henry Garland. California Med. **84**: 381–387, June 1956. (450 Sutter St., San Francisco, Calif.)

Cancer of the thyroid gland is relatively uncommon, showing an age adjusted incidence in the United States each year of approximately 1.1 per 100,000 males and 3.4 per 100,000 females. The pathological classification, methods of surgery, and the place of radiation therapy

are discussed in some detail. In none of these respects is there real agreement by the authorities in this field.

The author submits the following general plan of treatment:

Movable tumor, without metastasis or with mobile unilateral node metastasis: Usually surgical. No postoperative radiotherapy if the tumor is microscopically well differentiated and apparently totally removed. Radiotherapy if the tumor is poorly differentiated or incompletely removed.

Fixed tumor, or tumor with bilateral or fixed node metastases or with distant metastastic lesion: Usually radiotherapy after confirmation of diagnosis.

Radiosensitivity cannot be predicted and can be determined only by a trial of adequate irradiation. In general, it would appear that (1) most papillary-type tumors are moderately radiosensitive; (2) that about 50 per cent of follicular-type tumors are radiosensitive and (3) that tumors of undifferentiated type are usually radiosensitive, but incurable because of early generalized metastases. In general, the most effective treatment of inoperable carcinoma of the thyroid gland is by wide-field roentgen irradiation of the neck and adjacent tissues, including the cervical and upper mediastinal nodes. The usual plan is to attempt to deliver a mid-tumor dose of approximately 4,000 r in about four weeks, using orthovoltage radiation with a half-value layer of 2 mm. of copper. It is believed that this is biologically equivalent to about 6,000 gamma roentgens from a teleradium, telecobalt, or megavoltage source. In patients with widespread lesions of a follicular type which accepts radioactive iodine, that isotope should be used.

The author's results in 42 cases are analyzed. The five-year survival rate of non-terminal cases was 47 per cent.

JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

Surgical and Radiation Treatment of Carcinoma of the Breast. A New Concept. Bertram V. A. Low-Beer and H. Glenn Bell. Am. J. Roentgenol. **75:** 1162–1168, June 1956. (H. G. B., University of California School of Medicine, San Francisco, Calif.)

The authors state at the outset of their paper that the five-year landmark is not valid for carcinoma of the breast. Of patients with Stage I cancer treated radically, some 20 per cent are dead at five years and 45 per cent at ten years.

Actually, mammary cancer should be curable if it could be treated while still localized to the breast. The fact is that the existence of distant metastasis is the problem from the moment the primary tumor is discovered. To limit treatment efforts, therefore, to the first line of extension—the axillary, mediastinal, subclavicular and supraclavicular nodes—is to espouse an entirely erroneous basic concept of treatment. With this in mind, the authors sought to direct the primary treatment not only to the local area of involvement but also to any remote cancer tissue. For this purpose they made use of radiophosphorus as an internal selective cancerocidal agent.

The use of radiophosphorus was begun in 1941 and has undergone various modifications since that time. Since September 1953 all patients with carcinoma of the breast, including cases of Stage I, have been treated by surgery combined with internal and external irradiation. The first dose of P^{32}, for internal irradiation, has been administered while the patient is still on the operating table, as soon as a frozen-section diagnosis is made. From 20 to 30 microcuries (Na_2HPO_4) per kilogram of body weight is given intravenously at two- to three-day intervals "until the 'bone compartment' daily dose reaches a level of 15 to 20 gm. r/gm." (see Am. J. Roentgenol. **67:** 28, 1952). This dose level is usually reached in fourteen to twenty days and is maintained by additional doses for another ten to twelve days. The cumulative dose is estimated at 800 to 1,000 gm. r/gm. in the bone compartment and 75 to 100 gm. r/gm. in the soft-tissue compartment. The total dose ranges from 12 to 18 millicuries in approximately thirty days. Simultaneously the axilla and supraclavicular areas and the mediastinum are given external roentgen therapy.

It is as yet too early to draw any definite conclusions as to the efficacy of this treatment régime. Of 22 patients treated between July 1951 and July 1953, 5 had died. The only untoward effect of treatment was a temporary depression of the blood elements. Except in patients of advanced age, however, recovery of hematopoiesis was almost complete after four weeks.

JACK E. CARLISLE, M.D.
Shreveport, La.

Opportunity and Cervix Cancer. Herbert E. Schmitz. Am. J. Obst. & Gynec. **71:** 1283–1290, June 1956. (Stritch School of Medicine of Loyola University, Chicago, Ill.)

No stage of carcinoma of the cervix is completely without hope for cure; but the initial opportunity is the golden one. Carcinoma *in situ* requires careful evaluation and must be completely eradicated before that (not yet measurable) lapse of time until invasion occurs. In invasive disease, mortality statistics rise with the clinical extent of the disease. Still, with careful grouping and individualization, radiation therapy will produce, in unselected cases, results which cannot be duplicated by any other therapeutic methods.

The author reports the results in 116 cases treated by irradiation between 1946 and 1949. The survival percentage for the series was 43.1 per cent, and for the four clinical stages was as follows: Stage I (17 cases), 76.4 per cent; Stage II (31 cases), 54.8 per cent; Stage III (46 cases), 39.3 per cent; Stage IV (22 cases), 9.0 per cent. If this series is combined with an earlier one of 188 cases, seen between 1933 and 1945 (see Am. J. Roentgenol. **65:** 715, 1951. Abst. in Radiology **58:** 627, 1952), a total of 304 cases is obtained, with a survival rate of 43.4 per cent (83.8 per cent for Stage I; 64.0 per cent for Stage II; 40.0 per cent for Stage III; 10.9 per cent for Stage IV). Fifty-nine patients treated prior to 1945 and surviving at five years were followed further, showing 48 ten-year survivals. For 66 cases of recurrent or secondary cancer treated in 1946–49, the survival rate was 27.2 per cent.

The method of treatment in the usual primary case consists in weekly radium applications for three weeks. A 50-mg. straight radium capsule with 0.5 mm. platinum filtration was inserted for thirty hours for each application, for a total of 4,500 mg. hr. Point A received approximately 7,000 gamma r and point B 1,300 gamma r. Meanwhile external irradiation with 1,000-kv apparatus was used to add 3,500 r to both points A and B. An attempt was made to limit the dose to the bladder and rectum to 6,000 r or less.

Eleven tables; 1 drawing. ROBERT L. EGAN, M.D.
University of Texas, Houston

Surgery as an Adjunct to Irradiation Therapy in Carcinoma of the Cervix. Preliminary Report. Edward J. Crawford, Jr., Lewis S. Robinson, and Lloyd A. Hornbuckle. Am. J. Obst. & Gynec. **72:** 125–130, July 1956. (Confederate Memorial Hospital, Shreveport, La.)

This study is based on 27 cases of Stage I and 25 cases of Stage II carcinoma of the cervix first irradiated and then subjected to radical hysterectomy and pelvic lymphadenectomy. Each of the patients received a "full therapeutic application" of radium and x-rays. Estimated tumor doses are not stated. Surgery was done two to four months following completion of irradiation, and only those cases considered poor surgical risks due to heart or renal disease were excluded. There were 48 cases of primary squamous carcinoma, and 2 cases each of adenocarcinoma and squamous carcinoma of the cervical stump.

Of the 52 patients, 43 (83 per cent) were alive at the time of the report without evidence of recurrence, from six to fifty-four months postoperatively. Eight had died and 1 was living with known recurrent disease. In 13 patients viable malignant tumor was removed at surgery. Five of these had positive nodes and 8 residual cervical tumor; in 1 residual cervical cancer and node metastases were present. In 2 of the cervices tumor was found only in blood vessels. Of the patients without residual tumor or node metastases 95 per cent were still alive without disease; of the others, only 54 per cent survived.

There was one death from a massive pulmonary embolus on the twentieth postoperative day. Nineteen per cent of the series had postoperative urinary tract complications; there was one vesicovaginal fistula.

The authors realize the small size of their series but they feel that it does indicate that radical pelvic surgery can be carried out in the previously irradiated patient without markedly increasing the mortality or postoperative complications. No attempt has been made to answer their question: Does radical surgery in Stages I and II carcinoma of the cervix increase the survival rate of the previously irradiated patient?

Six tables. ROBERT L. EGAN, M.D.
University of Texas, Houston

Treatment of Choice in Cancer of the Uterine Corpus. John B. Graham. New England J. Med. **254:** 1112–1119, June 14, 1956. (Harvard Medical School, Boston, Mass.)

According to the International Classification, there are two stages of carcinoma of the uterine corpus: In Stage I, the disease is confined to the uterus. Such cases are further classified as Group 1, operable, and Group 2, technically operable but with certain clinical contraindications to surgery. Stage II includes all cases in which the growth has spread beyond the uterus and is therefore inoperable.

Four methods of treatment are reviewed: total hysterectomy, with and without preoperative radiation, radiotherapy alone, and radical hysterectomy with regional lymphadenectomy.

In cases of Stage I Group 1, hysterectomy, radiation therapy, and combined therapy are about equally effective. The author feels, however, that total hysterectomy is preferable because the risk is low and minimal time and discomfort are involved. Radiation therapy with Heyman's applicators is especially favored in Stage I Group 2 cases, in which the general condition of the patient precludes operation.

Preoperative irradiation increases the operability rate both by shrinking bulky tumors and by holding them in check long enough to permit general preparation of the patient (correction of heart failure, weight reduction, and so on). Use of Heyman capsules to deliver 2,000 gamma r to the entire wall of the uterus is recommended. Since metastases often appear adjacent to the urethra at the introitus and at the apex of the vagina, irradiation of the entire length of the vagina to deliver 2,000 gamma r 1 cm. beneath the surface is advised.

Full pelvis x-ray therapy postoperatively is felt by the author to be overly expensive and of questionable value. However, postoperative irradiation to the vagina with radium, as outlined above, has definite value and reduces recurrences in the vagina by two-thirds.

The value of radical hysterectomy with lymphadenectomy, such as is performed for cancer of the cervix, has not yet been proved.

Radiotherapy alone is indicated in all cases not suitable for total hysterectomy. If bleeding, pyometrium, or palpable tumor later develop, prompt hysterectomy is highly desirable.

There is incorporated in this excellent article a record of 518 cases of cancer of the uterine corpus and a review of various series from the literature.

Four tables. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

The Radiosensitivity of Granulosa-Cell Tumor of the Ovary. Basil A. Stoll. M. J. Australia **1:** 1004–1006, June 16, 1956. (Peter MacCallum Clinic, Melbourne, Australia)

Most granulosa-cell tumors of the ovary are removed surgically so that definite conclusions as to their radiosensitivity cannot be drawn. That they are, in fact, radiosensitive is indicated by the following considerations:

1. Radiosensitivity of the ovarian follicle and of granulosa-cell tissue in general.
2. Relief of uterine bleeding by low doses of radiation to the ovarian tumor, reported by many writers.
3. Reports of long-term survival in inoperable granulosa-cell tumors given full radiation (Moreton and Leddy: Am. J. Roentgenol. **59:** 717, 1948. Abst. in Radiology **52:** 773, 1949.)
4. Excellent response of metastatic growth to roentgen therapy.

Several reports of metastatic granulosa-cell tumor responding favorably to irradiation have appeared in the literature. To these the author adds the case of a forty-five-year-old pateint who had undergone bilateral ovariectomy with report of granulosa-cell tumor ten years earlier. Total hysterectomy in 1949 was followed by a 1,200 r tumor dose, but a chest film the following year showed metastases in the right lung, proved by biopsy to be granulosa-cell tumor. Peritoneal metastases also developed, but repeated x-ray therapy led to regression of both the pulmonary masses and relief of the abdominal symptoms. The patient survived for five years after the institution of radiotherapy.

Four roentgenograms.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

Importance of the Intestinal Flora in the Radiation Treatment of Gynecological Carcinomata. J. Breitner and W. Roth. Schweiz. med. Wchnschr. **86:** 759–761, June 30, 1956. (In German) (Strahlenabteilung der Universitätsfrauenklinik Basel, Basel, Switzerland)

During treatment for carcinoma of the female reproductive organs, irradiation of the bowel is sometimes unavoidable. The subsequent disturbances, mostly dyspeptic, have been said to be relieved by appropriate diet and especially by the administration of Hylak, a proprietary concentrate of albumin-free and lactose-free lactic acid and other low pH metabolites of microorganisms found in the so-called Yoghurt. The intent is to acidify the intestinal medium and thus restore the original balanced flora (eubacterial state) which has become altered (dysbacterial state) by alkalinization and/or other factors, among which even a direct influence by the carcinoma has been incriminated.

Bacteriologic stool examinations on 17 patients with carcinoma of the cervix, both before and after irradiation and administration of Hylak, compared with 17 apparently healthy controls, failed to demonstrate any significant differences in the intestinal flora. No objective change could be demonstrated after administration of Hylak, although definite subjective improvement was observed.

Three diagrams.

IRWIN F. HUMMON, M.D.
Cook County Hospital, Chicago

The Treatment of Wilms' Tumor. Elmer Ng and Bertram V. A. Low-Beer. J. Pediat. **48:** 763–769, June 1956. (University of California School of Medicine, San Francisco, Calif.)

Nine cases of Wilms' tumor are added to 18 previously reported, bringing the University of California Hospital series to a total of 27 cases, observed in 1926–54.

Thorough roentgen studies are indispensable in the diagnosis of this condition. Films of the chest and skeleton may demonstrate metastasis; plain films of the abdomen may show dense streaks and concentric rings of calcification within the tumor, thought by some to be of aid in differentiation from neuroblastoma and to have a favorable prognostic significance. Excretory urography was performed in all cases in the present series to ascertain not only the relationship of the mass to the involved kidney but also the status of the opposite kidney. In 1 of the patients, bilateral involvement was found immediately; in another, a tumor developed in the contralateral kidney post operatively.

Subsequent to 1936, all patients without evidence of distant metastases were treated by nephrectomy combined with radiation therapy. A mid-plane dose of 2,500 r was given in a period of three to four weeks, at 200 kv, with a half-value layer of 0.9 mm. of copper and a 50-cm. T.S.D. Anterior, posterior, and occasionally lateral fields were used, depending on the size of the tumor. Nephrectomy was carried out three or four weeks after irradiation and was followed in one or two weeks by a second course of radiation. The response to radiation was dramatic, the tumor shrinking to less than one-half its former size, with marked improvement in the general condition of the patient.

The combined results of the earlier and present series are as follows: Fourteen of the 27 patients had survived for at least two-and-one-half years at the time of the report, an absolute survival rate of 51.8 per cent. All of these had undergone nephrectomy, with or without irradiation. The surviving patients included 3 of 4 who underwent nephrectomy *without* irradiation (alive for more than ten years), 4 of 7 patients who underwent nephrectomy *with* postoperative irradiation, and 7 of 8 who received *both* pre- and postoperative irradiation.

If treatment is adequate, the authors consider the prognosis for this tumor to be relatively favorable. Further trial of preoperative irradiation, nephrectomy, and postoperative irradiation in unselected cases appears to be warranted.

Management of Malignant Testicular Tumors at the Radiumhemmet in Stockholm. Report on 247 Patients. Gustaf Notter. Acta radiol. **45:** 483–502, June 1956. (In German) (Radiumhemmet, Stockholm, Sweden)

The author reports 250 malignant tumors of the testis in 247 patients treated at the Radiumhemmet in Stockholm during the years 1921 to 1954. Of 214 patients observed from five to twenty-four years, 50 per cent had seminoma, 18.2 per cent embryonic carcinoma, 3.8 per cent adult teratoma, and 27.6 per cent teratocarcinoma.

Five-year survival rates were as follows: seminoma, 70.1 per cent (18.5 per cent for 27 patients with metastases and 87.5 per cent for 80 patients without); embryonic carcinoma, 12.8 per cent (10 per cent of 20 patients with and 16.5 per cent of 19 patients without metastases); teratoma, 50 per cent, all in patients without metastasis; teratocarcinoma, 42.8 per cent (12.5 of 24 cases with and 21 per cent of 35 without metastases. The crude five-year survival rates without respect to cell type indicated that 108 patients (50.5 per cent) were symptom-free, 4 were alive with metastases, and 102 (47.7 per cent) were dead.

Removal of the testis and radiation therapy to the site of the tumor and lymphatic drainage is recommended as the standard treatment. The mediastinum is not routinely irradiated except when there are clinically evident metastases in the epigastrium.

There was a history of cryptorchism in 12.2 per cent of the cases.

Pure seminomas secrete no choriogonadotropin, but 75 per cent of these patients have an increased output of follicle-stimulating hormone. This level is of no clear prognostic value.

In general, an increase of choriogonadotropin is unfavorable prognostically. This suggests either a chorionepithelioma or a mixed tumor. The output determination is valuable in following the patient clinically after treatment. The sedimentation rate is also of prognostic value. Metastases should be sought when it is elevated. Of 50 patients who had died, only 3 had a normal sedimentation rate.

The following signs are taken by the author to indicate a good prognosis: absence of metastases at the beginning of treatment, absence of infiltrating growth outside the testis, normal choriogonadotropin output, good general condition and normal hematopoiesis.

Two roentgenograms; 2 drawings; 7 tables.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Neuroblastomas in Infancy and Childhood. A Review of Ten Years' Experience. C. W. Reiquam, E. C. Beatty, Jr., and R. P. Allen. J. Dis. Child. **91:** 588–592, June 1956. (Children's Hospital, Denver, Colo.)

During a ten-year period 25 children with neuro-

blastoma were treated at the Denver Children's Hospital. Twenty were under two years of age and the remaining 5 were betweeen two and seven years. Twenty-four of the 25 had a primary retroperitoneal or retropleural tumor; in the twenty-fifth the primary site was not ascertained. Pathologically, the tumors show varying degrees of maturation from case to case as well as within a single tumor.

In 6 of the 25 patients an asymptomatic mass was felt on routine examination. Five of these 6 are alive and apparently well fourteen months after diagnosis; the sixth died five months after treatment from radiation nephritis, with no evidence of residual tumor at necropsy.

Clinically the vague symptoms of low-grade fever, malaise, leg aches, cough, and mild anemia occur in so many less serious pediatric conditions that they are often overlooked. The one sign that may be of some help in focusing attention on the possibility of an underlying neuroblastoma is the refusal of the child to use an extremity or the sudden appearance of a limp with or without the complaint of pain. This had been noted in the literature and was observed in 9 of the authors' series. Not too much time should be spent trying to prove the etiology to be rheumatic fever in an older child or early osteomyelitis in an infant. X-ray examination serves to delineate the tumor in the abdomen or at the metastatic site in all but the exceptional case.

Generally, therapy has consisted of surgical removal of the tumor, followed by radiation begun on the first postoperative day. Radiation is given through alternating anterior and posterior portals as small as is consistent with adequate coverage, with an air dose of 200 r daily until a tissue dose of 1,200 r is attained. Lateral portals have been avoided, since the death of one child from radiation nephritis, as mentioned above. The treatment course is repeated in two months. Larger children may require additional portals if there is extensive abdominal involvement.

Marrow depression leading to general debility appears to be the only limiting factor in radiation therapy; skin reaction and wound healing pose no significant problem. Minimal growth disturbances of the spine have been observed in 2 survivors but this has not been sufficiently serious to alter the therapeutic régime. Liver metastases are treated, as are those in the bone, but the latter are usually too extensive to be given adequate dosage and thus respond poorly. Preoperative irradiation has not been necessary to shrink the tumor and any other effect is unproved.

Ten of the authors' patients were treated by excision of the primary tumor and irradiation, with 3 surviving at the time of the report, at least eighteen months after diagnosis, without metastases. Two other patients in this group died less than a year after treatment without evidence of tumor at autopsy. A third survived for two years to die of extensive metastases.

Seven patients were untreated and all died. Among the remaining 8 were 2 alive at the time of the report, two and a quarter years and fourteen months, respectively, without evidence of recurrence. Both these patients were treated by irradiation, following biopsy.

Skeletal metastases are of particularly grave concern; no patient showing this complication survived. It is also significant that the survival rate for children under one is higher than for those in whom the diagnosis is not made until the age of two or over. If the child survives twelve to eighteen months after diagnosis and is still free of disease, he is most likely cured.

Two tables.

SAUL SCHEFF, M.D.
Boston, Mass.

An Evaluation of Beta Irradiation Therapy in Ophthalmology. Carroll W. Browning. South. M. J. **49:** 298–303, March 1956. (Division of Ophthalmology, University of Texas, Southwestern Medical School, Dallas, Texas)

The author discusses the principal therapeutic indications and complications of beta irradiation in ophthalmology, based on six years experience with four types of applicators and on recent reports in the literature. An optimistic attitude but conservative use of beta ray therapy about the eye is recommended until the long-term behavior of beta-induced cataracts is definitely evaluated.

Cortisone versus X-Ray in the Treatment of Subacute Thyroiditis: A Report of Four Cases. Lawrence Taylor. Ann. Int. Med. **44:** 1082–1087, June 1956. (Bryn Mawr Hospital, Bryn Mawr, Penna.)

In a review of the literature, the author found accounts of the successful treatment of subacute thyroiditis by x-rays, thiouracil, ACTH, cortisone, and thyroid-stimulating hormones. Here he presents 4 cases of subacute thyroiditis of which 3 were treated with cortisone, with 1 excellent and 2 unfavorable responses. One case responded well to irradiation following a partial response to cortisone. The fourth case responded well to roentgen therapy alone, cortisone having been withheld because of severe diabetes mellitus.

The author concludes that cortisone produces immediate relief of the signs and symptoms of subacute thyroiditis, but, as in all other diseases so far reported, merely suppresses the manifestations. He feels that in severe cases the side effects and danger of long-term therapy may outweigh the clinical benefit.

Since x-ray therapy continues to have a curative effect in a high percentage of cases, without side effects or relapses, it should be considered superior to cortisone alone. In severe cases combined therapy, with cortisone for immediate effect and irradiation for prolonged effect, is worthy of further trial.

One graph.

JAMES E. BAUER, M.D.
University of Missouri

Basic Aspects of Radiation Therapy. W. S. Moos. J. Urol. **75:** 881–891, June 1956. (840 S. Wood St., Chicago 12, Ill.)

This paper was presented before a section of the American Urological Association, in the hope of contributing to "the appreciation and furtherance of interest in radiological medicine." It is concerned with fundamentals which are familiar to the radiologist. The author first considers the essential concepts of radiation physics, distinguishing between electromagnetic radiation and particle radiation; the various types of generator—transformer-fed and electrostatic, the betatron, linear accelerators, etc.; radioactive isotopes, both naturally occurring and artificially produced.

The latter part of the paper is devoted to the actual application of the various radiation sources, with a comparison of the advantages and disadvantages of 200-kv, supervoltage, and megavoltage x-rays in therapy, a consideration of electron-beam therapy, and

reference to the use of radium, radon, and the more commonly employed isotopes, as cobalt 60, gold 198, iodine 131, and phosphorus 32.

Nine illustrations.

WILLIAM T. THORWARTH, M.D.
University of Pennsylvania

Periodic Control of the Function and Constancy of Ionization Chamber Dose Meters. R. Thoraeus. Acta radiol. **45**: 503–511, June 1956. (Institute of Radiophysics, King Gustaf V Jubilee Clinic, Karolinska Sjukhuset, Stockholm, Sweden)

The author points out that measurement of x and gamma radiation in terms of absolute r units can be realized only through the use of a standard free-air ionization chamber designed in accordance with the definition of the unit. Because such an instrument is impracticable in most clinical and experimental radiologic work, ionization chambers of other types are necessary. These are usually of the small closed ionization chamber type. Most functional principles of the closed chambers are fundamentally different from those of a free-air standard chamber, and for that reason every dose meter provided with a closed chamber must be extensively calibrated against a free-air standard chamber. Since such extensive calibrations involve considerable time and effort, the author has designed an apparatus for relatively rapid and simple periodic checks of closed ionization chamber function.

In referring to the system of "checks" which are available on a variety of commercial dose meters to determine the consistency of the instrument, the author emphasizes that such calibration checks have to do with the operation of the counting or reading mechanism only, and may give results in the normal range when the ionization chamber itself is seriously damaged or even absent. It may thus be dangerous to rely on such superficial tests for consistency of a meter for use in hospital and clinical practice.

Several requirements of a reliable gamma radiation standard are listed and the radium gamma-ray source designed by the author to meet his purposes is described. Suffice it to say that this source was planned to be as nearly a point source as possible, with a critically measured amount of radium element and critically measured purity and thickness of the container walls. A device was manufactured which permits an accurate and reproducible geometry between the closed ionization chamber being calibrated and the radium gamma ray source. Standard distance rods between the radium source and the thimble chamber are used to compensate for differing chamber capacities and to provide for an exposure time of sufficient length to insure reasonable accuracy.

The article contains four figures giving details of construction of the radium source and of housing devices permitting the irradiation of one, two or three closed ionization chambers simultaneously. One table lists the results obtained in the calibration of one such chamber.

The author has found that closed condenser type ionization chambers may be consistently and accurately calibrated by an experienced technical assistant and that a maximum of five meters may be checked in an eight-hour day, with calibration of one meter at a time. In the course of such an eight-hour day the technician receives an exposure of approximately 9 milliroentgens of gamma radiation.

JAMES E. BAUER, M.D.
University of Missouri

RADIOISOTOPES

Diagnostic Tests that Depend on Radioisotope Localization. Marvin M. D. Williams and Donald S. Childs, Jr. Am. J. Roentgenol. **75**: 1040–1058, June 1956. (Mayo Clinic, Rochester, Minn.)

In diagnostic tests which depend on the localization of a radioisotope, the radioisotope must localize differently in the condition to be diagnosed than in other conditions. This difference may be the rate at which the isotope is localized, the rate at which it leaves, the total amount which is localized, or a combination of these. Sometimes the test involves a determination of the formation or rate of formation of a new compound, or its reverse, the breaking up of a compound.

Radioisotopes are useful as diagnostic agents only because they emit radiations which make it possible to detect their presence. The radiations which are emitted are either beta particles or photons. Most of the beta particles are negative electrons, but some are positive electrons (positrons), traveling only a few millimeters in tissue.

Most of the measuring devices use either Geiger or scintillation counters or photographic methods. Beta particles may be counted by Geiger counters with thin walls or scintillation counters. For counting photons, scintillation counters are generally 20 to 100 times as efficient as Geiger counters. Scintillation counters have the further advantage that they can be operated so as to measure one isotope in the presence of others.

For diagnostic purposes P^{32}, in the form of sodium phosphate, is generally given intravenously in amounts up to 1 millicurie. Its value as a diagnostic tool is due to its being taken up by rapidly metabolizing tissues. Thus malignant breast tumors and metastatic nodes showed at least 25 per cent greater activity than corresponding normal areas twenty-four to forty-eight hours after administration of the isotope. As inflammatory lesions also concentrate the isotope, false positive findings may be obtained.

P^{32} is similarly used for evaluation of brain tumors, testicular tumors, intrathoracic tumors, gynecological tumors, gastrointestinal tract tumors, and tumors of the eye. It has been employed also as an indicator of the blood supply to the femoral head following fracture of the neck of the femur. Following an intravenous dose of 280 μc., the P^{32} content of a segment of bone from the femoral head and from the intertrochanteric region can be determined at operation.

Radioactive potassium (K^{42}) has been used in similar fashion to P^{32}. It has a shorter half-life, a more energetic beta particle, a penetrating gamma ray, and a more rapid uptake by the tumor. Potassium concentrates rapidly in muscle, thereby making it difficult to distinguish a tumor in proximity to a muscle. Its use in studies of breast tumors and brain tumors is reviewed.

Radioactive copper (Cu^{64}) can be detected because of the annihilation radiation which results when its positron combines with an electron. This characteristic has been used in an effort to detect brain tumors but

as yet not enough work has been done for reliable evaluation.

Radioactive arsenic, either as As^{74} or As^{76}, has also been employed for localization of brain tumors.

Gallium has several radioactive isotopes, most of which are short-lived. Usually Ga^{72} or Ga^{67} has been used, primarily in the study of bone tumors.

Radioactive iodine is usually employed in the form I^{131}, with a half-life of 8.05 days, which is ideal for most biological investigation. Radioiodine, as sodium iodide, is of aid in investigations of the thyroid and for tagging other compounds, such as diiodofluorescein (DIF) and iodinated human serum albumin (IHSA or RISA). The use of DIF and IHSA in the localization of brain tumors and spinal cord lesions is reviewed in considerable detail. These two substances have also been employed in evaluation of liver tumors and gallbladder function. Many forms of thyroid function tests with I^{131} are described.

Radioactive gold (Au^{198}) has been used extensively as a therapeutic agent. It may serve as a diagnostic tool in the study of liver tumors because of the affinity of reticuloendothelial cells of the liver for colloidal matter. Areas of decreased radioactivity of the liver were found to be produced by any space-occupying lesion.

JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

Some Applications of Isotope Dilution Techniques. Rosalyn S. Yalow and Solomon A. Berson. Am. J. Roentgenol. **75:** 1059–1067, June 1956. (R. S. Y., VA Hospital, New York 68, N. Y.)

The chemical and physical properties of the radioisotopes provide a multitude of physiological tracers for the measurement of the volume of a closed compartment. The dilution technic requires the introduction of a known amount of the tracer into the compartment and the determination of its concentration after a time sufficient to insure complete mixing. The compartment size is calculated as the total activity of the tracer in the compartment divided by the concentration of activity in a representative sample.

Tracers for the measurement of blood volume are distributed either with the red cells or with the plasma. Commonly used radioactive isotope tracers for erythrocytes are P^{32}, K^{42}, Cr^{51}, Fe^{55}, and Fe^{59}. The iron isotopes can label red cells only in vivo, so that radioactive iron must be fed to donors to be incorporated into their erythrocytes. Radioiron-tagged cells transfused from these donors are then used for blood volume determinations. The subject's own erythrocytes can be tagged with radioactive potassium, phosphorus, or chromium by incubation in a test tube for an hour or two. As tracers for plasma, separated plasma proteins have been labeled chemically with I^{131} and employed for blood volume determinations.

When a red-cell label and a plasma label are given simultaneously, the whole blood volume calculated from the dilution of the plasma label is generally about 10 per cent higher than that calculated from the dilution of the labeled cells. This is explained on the basis that mixing of tagged red cells and plasma is not uniform throughout the body and samples obtained from peripheral vessels are not representative of the entire pool of circulating blood. Therefore, the true total blood volume cannot be obtained from the apparent space of dilution of either red cells or plasma alone but is the sum of the separately measured red cell and plasma volumes.

A technic is suggested which makes possible serial determinations of acute changes in blood volume when the changes are due solely to alterations in plasma volume. Following the intravenous administration of P^{32} labeled erythrocytes to a patient at bedrest, the rate of decrease of the concentration of radioactivity in whole blood is constant for a few days or more. A plot of these data on semi-logarithmic paper gives a straight line, which usually has a half time of about twenty-four hours. This line, obtained during a control period, is extrapolated into the period of interest. Changes in plasma volume can then be quantitated from the rise or fall with respect to the extrapolated line. A decrease in plasma volume was shown to occur when the subjects assumed the erect position and walked about; an increase in plasma volume occurred within an hour or two after return to the horizontal position in bed. These observations confirm the need for a period of bed rest of at least several hours before making blood volume determinations.

Serial blood-volume estimates were made in cardiac patients before and after digitalis administration. After treatment, the first effect observed was an increase in the rate of urine excretion followed by a decrease in plasma volume. This would indicate that the diuretic effect of digitalis is not due to a primary mobilization of edema fluid, as a result of reduction of venous pressure, but rather that the initial effect may have been on the kidney through an improvement in cardiac output.

Total-body water is measured from the dilution of deuterium or tritium-labeled water. In normal subjects equilibrium with the bulk of body water is essentially complete in about one hour. In the presence of abnormal fluid accumulations, such as ascites, equilibrium may not be approximated until about ten hours.

Dilution technics have also been employed for determination of exchangeable sodium and potassium, total exchangeable serum albumin, and exchangeable thyroid hormone. I^{131} labeled serum albumin is employed for the determination of total exchangeable albumin. The rate of decrease of plasma radioactivity, corrected only for radioactive decay, is the rate of degradation of iodo-albumin and has been presumed to indicate the rate of metabolism of the patient's endogenous albumin.

The determination of total exchangeable thyroid hormone represents a slightly more complicated application of the *in vivo* dilution technic. The thyroid gland itself is generally the depot for the largest fraction of the hormonal pool, and tagged thyroid hormone does not exchange directly with this pool. The extrathyroidal hormonal pool has been measured directly, utilizing I^{131}-labeled l-thyroxine or l-triiodothyronine or plasma from patients treated with large doses of I^{131} and an antithyroid agent, Tapazol.

Two graphs.

JOHN T. WEIGEN, M.D.
Palo Alto, Calif.

Isotope Studies of Blood Flow and Blood Cells. Edith H. Quimby. Am. J. Roentgenol. **75:** 1068–1081, June 1956. (630 W. 168th St., New York 32, N. Y.)

This paper reviews the methods by which isotopes may be used to study many phases of the circulatory system including the circulation time, the adequacy of circulation in various parts of the vascular system, and the production and life span of the blood cells themselves.

The studies of Wright, Osborne *et al.* (see, for exam-

ple, Lancet 1: 22, 1951; 2: 699, 1952) on the venous return from the lower extremities as determined by radioactivity measurements in surgical patients are cited. These revealed no slowing of the blood flow in those who were ambulatory, but in those confined to bed venous return was progressively slowed until about the twelfth day, following which some improvement occurred. This is of particular interest in that it is in the second postoperative week that thrombophlebitis seems most likely to develop in such patients. Similar slowing was not found in medical patients and the difference was attributed to the relatively greater activity of this group compared to postoperative patients, even though both are confined to bed.

In radiocardiography the pattern of passage of radioactive sodium is mapped as it passes through the right side of the heart, the lungs, and the left cardiac chambers. It is suggested that tracings thus obtained may well take their place with electrocardiograms after the method has been perfected. Radiocardiograms obtained before and following surgical correction of a patent ductus arteriosus are reproduced.

By the use of various isotopes the cardiac output may be measured as well as the circulation to localized areas. In this way the adequacy of circulation within the vascular bed proper, as well as in the entire tissue bed, can be determined. A decided improvement in circulation in the tissue bed of the foot is demonstrated in hypertensive patients following bilateral thoracolumbar sympathectomy. This same circulatory function can be evaluated in reverse fashion by injecting a minute amount of isotope into the tissue to be studied and determining its rate of disappearance, or clearance. Many applications of these circulation tests are described.

The use of radioactive iron makes it possible to study the utilization of iron in various types of anemia. During the developmental stage of the red cell, iron is built into the hemoglobin molecule and remains fixed until the cell is destroyed. Mature erythrocytes do not show active uptake of iron *in vitro*. Following the injection of iron into the circulation approximately 75 per cent is finally in the form of hemoglobin, with the remainder in the form of storage iron. In iron deficiency and blood-loss anemia, initial utilization is more rapid and more complete. With bone marrow dysfunction, the utilization curve is lower and flatter. Methods for studying iron utilization are presented. Methods are also described for the study of other phases of iron metabolism, red cell survival, white cell production and survival.

The work of a large number of authorities is cited and an extensive bibliography is appended.

Two radiocardiograms; 13 graphs.

JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

Isotopes and Nuclear Radiations in Experimental Medicine. John H. Lawrence. Arch. Int. Med. **97**: 680–693, June 1956. (Donner Laboratory, University of California, Berkeley, Calif.)

This paper opens with some comments upon the tremendously rapid increase in the use of radioisotopes in the United States, notably I^{131} in the diagnosis and treatment of Graves' disease and thyroid cancer, P^{32} and other isotopes in the measurement of blood volume and the treatment of polycythemia vera, leukemia, and allied diseases, Fe^{59} in the study of red cell production, and radiocolloids for the palliation of pleural and peritoneal carcinomatoses. Mention is also made of the radiation therapy units using radiocobalt and radiocesium and the new accelerators such as the betatron, the bevatron, the synchrotron, and the synchrocyclotron for the deep therapy of cancer.

Following these opening remarks, the author proceeds to present some examples of how such tools are being used. Among these are blood volume determinations, not only for the diagnosis of polycythemia and anemia but in other chronic diseases and as a preliminary to surgery; studies of iron metabolism and of the production and life span of the red blood cells; determination of body water, with its many medical and physiological applications.

The use of P^{32} in the treatment of polycythemia and leukemia is discussed at some length. Patients with polycythemia may now look forward to an almost normal life span. The median survival in a series of 231 patients treated with radioactive phosphorus is shown to have been 13.2 years. This increase over cases treated with conventional methods is attributed chiefly to the lessened incidence of thrombosis and hemorrhage through control of the red cell volume and platelets. The results in leukemia are somewhat less satisfactory, though still worthwhile. The author has tried chromic radiophosphate and other radiocolloids in this condition, but did not find them superior to P^{32} as disodium phosphate.

The newer forms of external radiation therapy are illustrated by the use of the synchrocyclotron, with a 340-MEV proton beam. This has recently been used at the University of California to irradiate the pituitary in patients with advanced carcinoma of the breast. The author and his colleagues have shown that irradiation hypophysectomy is entirely feasible and accurately performed in experimental animals, and the procedure has been employed clinically in 33 patients. A case is described in which pituitary irradiation with 14,000 rads during a period of sixty days caused a disappearance of the pituitary gonadotropins in the urine and a marked decrease in the iodine uptake by the thyroid gland, indicating suppression of both follicle-stimulating and thyroid-stimulating hormones. Similar effects were observed in the other 32 patients. This is believed to be the first clear-cut evidence that target organ effects can be brought about by pituitary irradiation.

JAMES E. BAUER, M.D.
University of Missouri

A Study of Methods for Interstitial Implantation of Radioactive Materials. H. C. Dudley and T. G. Mitchell. Am. J. Roentgenol. **75**: 1084–1092, June 1956. (H. C. D., U. S. Navy Hospital, St. Albans 25, N. Y.)

Special compounds of radioactive phosphorus (P^{32}), gold (Au^{198}), and yttrium (Y^{90}) prepared by the authors were injected or implanted in the interstitial tissues of experimental animals. Local and remote radiation effects were observed and evaluated at autopsy of the animals in seven to fourteen days.

Studies of subcutaneously injected insoluble compounds of P^{32} indicated that only the titanium compound, and to a lesser degree chromium compounds, were of sufficient insolubility to prevent some breakdown with release of soluble phosphate into the general body tissues. A special preparation of titanium phosphate with germanium oxide allowed even less trans-

location of the radioactive phosphorus, with more sharply localized tissue effects.

Glass-like filaments of fused germanium oxide containing Au^{198} or P^{32} were implanted subcutaneously. It was found that the gold compound exerted sharply localized radiation effects with minimal translocation but that the phosphorus compound entered the general circulation in significant quantities. Specially prepared, flexible, plastic filaments of methylcellulose containing Y^{90} showed the most sharply localized radiation effects of any substance tested and no significant translocation of the yttrium occurred.

Histologic studies of implanted filaments or injection sites showed dense, white, avascular scar tissue of sharply limited extent surrounding the radioactive deposits to a thickness of 1 or 2 mm. up to 11 mm., depending upon the activity and nature of the substance implanted. The effects are felt to be results of pure beta irradiation. Radioactive substances which reached the general circulation tended to be deposited in high concentration in cortical bone and in the spleen.

The authors describe in considerable detail the physical preparation of these special radioactive compounds. They conclude: "Use of filaments which are soluble in tissues offers a convenient means of implanting radioactive materials or other drugs in order to : (*a*) destroy a discrete area in central nervous system or glandular tissue; (*b*) implant tumor-producing areas; (*c*) attempt local destruction of neoplasm by implantation in or lacing through the lesion; and (*d*) attempt destruction of blood supply of lesion by marked local scarification with Y^{90}." They believe that of all the substances yet tested, plastic flexible filaments containing Y^{90}, a pure beta emitter, offer the best prospects.

One graph; 3 tables. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Calculation of Maximum Permissible Concentrations for Long-Lived Radioisotopes. J. W. Healy. Radiation Res. **4:** 367–372, May 1956. (Radiological Sciences Department, General Electric Co., Richland, Wash.)

In the computation of maximum permissible concentrations (MPC) of radioisotopes in air, water, or foodstuffs, the allowable rate of intake to the body is governed by the maximum permissible body burden and by the rate at which previously accumulated isotopes are eliminated either by radioactive decay or by metabolic processes. The metabolic elimination is usually considered to follow an exponential relationship which implies a constant fraction of the burden eliminated per unit time, regardless of the time since administration. Several investigators have observed that the excretion of many isotopes appears to follow a straight-line relation when plotted on logarithmic paper, indicating that a progressively decreasing fraction of the body burden is excreted per unit time. This relationship is most simply represented by a power function. Recent studies at Argonne National Laboratory have also indicated that the long-term retention of radium by the human being follows a power law and have further resulted in equations indicating the relationship between retained quantity and excretion rates (see, for example, Norris *et al.*: Am. J. Roentgenol. **73:** 785, 1955. Abst. in Radiology **66:** 484, 1956). In the present paper the author discusses the application of the power function for retention or excretion of isotopes to the calculations of maximum permissible concentrations of radioisotopes in air or water. The MPC's of Ra^{226} and Sr^{90} are calculated as examples of the technic.

Three tables.

A Clinical Appraisal of Radioiodine Tests of Thyroid Function. William M. McConahey, Charles A. Owen, Jr., and F. Raymond Keating, Jr. J. Clin. Endocrinol. & Metab. **16:** 724–734, June 1956. (Mayo Clinic, Rochester, Minn.)

The authors studied the results of seven different radioiodine tests of thyroid function in a total of 389 patients who were classified on the basis of thyroid function. The final diagnosis of hyperthyroidism, euthyroidism, or myxedema was made in every case, following a careful review of the record, on the basis of clinical evaluation, basal metabolic rate, serum protein-bound iodine level, clinical course, and response to treatment, and was entirely independent of the radioiodine tests being evaluated.

Seven radioiodine tests were evaluated: (1) six-hour thyroid uptake, (2) twenty-four-hour thyroid uptake, (3) twenty-four-hour urinary excretion, (4) thyroid accumulation rate, (5) extrarenal disposal rate, (6) conversion ratio, and (7) thyroidal iodide clearance. The methods were evaluated in terms of their economy, the time required, and the ease of performance, as well as diagnostic precision.

The normal range of values of each test studied was obtained by analysis of results of each of the seven tests in 181 euthyroid patients. For each test, the range between the 2.5 and the 97.5 per cent levels was chosen as the normal range.

All of the seven radioiodine tests studied were relatively accurate for the diagnosis of exophthalmic goiter, since in relatively few instances did values overlap those of the normal range. The six-hour thyroid uptake, the thyroidal iodide clearance, and the conversion ratio were more accurate than the other tests in making this diagnosis. In 20 patients in whom the clinical diagnosis was originally in doubt but who were subsequently proved to have hyperthyroidism, the six-hour uptake, thyroidal iodide clearance, and conversion ratio were of diagnostic accuracy in indicating hyperthyroidism. These three tests were also consistently accurate in indicating the absence of hyperthyroidism in 38 patients subsequently considered to be euthyroid.

The six-hour and twenty-four-hour thyroid uptake studies (particularly the former) were of considerable discriminatory value in the diagnosis of myxedema. In 13 patients, all six-hour uptake values fell below the normal range. The authors point out that such low values may be obtained also in normal or hyperthyroid individuals who have been receiving iodine from various exogenous sources.

The ranges established in this study for the two thyroid uptake tests are as follows:

	181 Cases No Thyroid Disease	92 Cases Exophthalmic Goiter	13 Cases Myxedema
Six-hour uptake	% 7.5—25.0	% 33.2—89.6	% 1.7—6.7
Twenty-four hour uptake	11.9—46.5	39.9—88.6	0.6—18.1

In summary, the authors conclude that the most precise tests for the diagnosis of exophthalmic goiter are

the six-hour thyroid uptake, the thyroidal iodide clearance, and the conversion ratio. The first test is the simplest and most rapidly performed and requires the least radioactivity; hence, it is the best for the requirements of a routine radioiodine test. Only two tests, the six-hour and twenty-four-hour thyroid uptake studies, were of value in the diagnosis of myxedema. None of the tests was decisive in determining whether the patient with nodular goiter was or was not hyperthyroid.

One figure; 5 tables. JAMES E. BAUER, M.D.
University of Missouri

Further Clinical Studies of Thyroid and Salivary Gland Function with Radioiodine. C. H. Jaimet and H. G. Thode. Canad. M. A. J. **74:** 865–870, June 1, 1956. (Hamilton College, McMaster University, Hamilton, Ontario, Canada)

Radioiodine saliva tests for thyroid function were evaluated in more than 400 patients. Not only was the test determining saliva activity in relation to the protein-bound iodine activity in the plasma (S-PBI ratio) found to be almost 100 per cent accurate, but in many cases where the results in other radioiodine tests were inconclusive the S-PBI findings were clear-cut and more consistent with the final diagnosis.

Advantages of the S-PBI test for thyroid function are given as follows: (*a*) the test is equally accurate with radioiodine pick-up and conversion ratio tests for hyperthyroidism; (*b*) it gives an accurate indication of hypothyroidism, whereas the results in other tests are disappointing (with the exception of the thyroid-stimulating hormone test); (*c*) it seems to follow clinical symptoms more closely in patients under treatment with radioiodine, propyl thiouracil, and other agents.

Finally, the excellent correlation between saliva tests and thyroid function represents strong clinical evidence for a connection between the salivary and thyroid gland systems and supports the findings of others (Fawcett and Kirkwood: J. Biol. Chem. **205:** 795, 1953) that the salivary glands play an important role in the iodine cycle in the body, perhaps in the degradation of organically bound iodine.

Four tables.

The Uptake of Radioiodine by the Thyroid Cells Using Nuclear Emulsion. Adrian G. Basser. M. J. Australia **1:** 1003–1004, June 16, 1956. (Unit of Clinical Investigation, Royal North Shore Hospital of Sydney, Sydney, Australia)

Demonstration of the selective concentration of I^{131} in the epithelial cells of the thyroid follicle is possible by incorporating a section of thyroid (3 to 4 micra in thickness) and a photographic emulsion on one slide. This gives perfect apposition between emulsion layer and histologic section. Some radioiodine is found in the colloid, but a much greater concentration is evident in the cells.

A special electron-sensitive emulsion, called "nuclear emulsion," is employed. This emulsion has a high content of silver halides, which enables a greater degree of accuracy in localization of radioactive material in the thin histologic sections. With this method iodine could be demonstrated in the cells after tracer doses of as little as 2 microcuries per kilogram of body weight. Alcohol alone was used as a fixative.

More accurate localization of radioactive material histologically within cells is helpful in determining where protein-binding occurs. The present materials suggest that this is primarily in the thyroid epithelium and not in the colloid.

Two illustrations. DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

The Role of Radioiodine in the Treatment of Carcinoma of the Thyroid. Gwen Hilton, E. E. Pochin, R. M. Cunningham, and K. E. Halnan. Brit. J. Radiol. **29:** 297–310, June 1956. (G. H., Radiotherapy Department, University College Hospital, London, W.C.1, England)

The authors present an unusually lucid and concise review of the role of radioiodine in the treatment of thyroid carcinoma based on a series of 73 cases. They feel that all operable thyroid carcinomas should be treated primarily by surgery. All other tumors which take up or can be induced to take up iodine are suitable for I^{131} therapy. But tumors with very high uptake rates may discharge the iodine with equal facility and the radioiodine may not be retained long enough to deliver an effective tumor dose. Other factors such as the radiosensitivity of the tumor, its total mass, and the effect of local invasion influence the response to irradiation, although to a lesser extent. It is also pointed out that metastases in the vicinity of certain iodine-concentrating organs, such as thyroid, liver, kidneys, bladder, stomach, and salivary glands, are difficult to evaluate in regard to uptake.

Thyroid tumors can in general be classified histologically into the following types:

1. Primarily follicular carcinoma: Good uptake and response.
2. Follicular carcinoma with some anaplastic elements: Good uptake and response but with a tendency to recur.
3. Predominantly papillary: Variable uptake and response, from no uptake to good uptake.
4. Mixed papillary and follicular: Good uptake and good response.
5. Anaplastic: No uptake and no response.

Many tumors which show no uptake initially will have an excellent uptake after ablation of the normal thyroid, and this latter procedure is useful in all histologic types except a rapidly enlarging anaplastic carcinoma. Surgical excision is the method of choice for ablation where possible; otherwise radioiodine may be used.

The authors prefer an initial dose of about 150 mc for therapy. This dose is repeated at intervals of six to eight weeks as long as the uptake remains above 0.1 per cent. Once it falls below this point, the interval is lengthened to three or four months and treatment is continued until the uptake falls to 0.01 per cent. At this time therapy is discontinued and the patient is followed expectantly. Tumors with widespread bony metastases should be treated cautiously, since blood changes may be sufficient to necessitate premature cessation of therapy.

The most serious sequela of treatment is myxedema, which, however, may be effectively controlled by daily doses of thyroxine. This should be omitted for one month prior to the administration of a therapeutic dose of radioiodine. Dry mouth and throat, mucositis, tenderness and mild skin erythema over the tumor site, epilation, parotid gland swelling and tenderness, and mild leukopenia are commonly seen, but are usually transient. Often there is a rapid reduction in tumor

mass with rapid relief of symptoms. Occasionally amenorrhea is seen and in younger patients it may be permanent.

Only 7 patients of the present series had a follow-up of five years or more, and 5 of these are still living. The authors believe that all patients (operable or inoperable) in whom the tumor concentrates iodine should receive radioiodine therapy. Certainly inoperable cases are thus offered their only hope. External irradiation is used only for tumors which do not demonstrate any iodine uptake.

Five roentgenograms; 5 photomicrographs; 6 charts; 3 tables.

JOHN LANE, M.D.
University of Arkansas

Four Cases Illustrating the Use of I^{131} in the Management of Metastatic Carcinoma of the Thyroid. John P. Storaasli and Donald P. King. Am. J. Roentgenol. **75:** 1150–1161, June 1956. (J. P. S., 2065 Adelbert Rd., Cleveland 6, Ohio)

Forty to fifty per cent of all patients with metastatic carcinoma of the thyroid show selective uptake of iodine, but only a few of these retain sufficient amounts to warrant initial therapy with I^{131}. Adequate concentration of the isotope is to be expected only in cases in which there is histopathologic evidence of follicle formation either in the primary cancer or in the metastases. It is also necessary that any normal thyroid tissue first be destroyed either by radiation or surgery, since it inhibits iodine concentration by the neoplasm. Antithyroid drugs, notably thiouracil, act to enhance the iodine-concentrating capacity of the tumor.

High dosage of I^{131} is required—100 to 200 mc in a single treatment, repeated at intervals of three or four months until the tumor no longer demonstrates avidity for iodine. By this time, myxedema will be evident. The patient is then given desiccated thyroid and is closely watched for evidence of tumor growth. If this occurs, thyroid medication is discontinued and I^{131} tracer studies are instituted to detect any functioning tissue.

Four cases are reported, illustrating some of the problems involved in treatment of thyroid cancer by radioactive iodine and lending emphasis to the points mentioned above. Three of the patients were alive in May 1955, after the institution of treatment in 1949, 1951, and 1953, respectively. Epilation was noted in one patient with a skull metastasis.

Complete destruction of all metastases is seldom achieved, but palliation and prolongation of life are remarkable in properly selected cases. In the light of present knowledge, pure papillary adenocarcinomas, Hürthle-cell adenocarcinomas, solid adenocarcinomas, and anaplastic carcinomas are not amenable to radioactive iodine treatment.

A major reason for failure of treatment is lack of uniformity of function either within a single metastasis or among separate metastases, with consequent uneven distribution of the isotope. Treatment is almost invariably followed by a transient leukopenia.

Fifteen roentgenograms; 4 photomicrographs.

JACK E. CARLISLE, M.D.
Shreveport, La.

Acute Myeloid Leukemia After Radioactive-Iodine Therapy. John D. Abbatt, Helen E. A. Farran, and Raymond Greene. Lancet **1:** 782–783, May 26, 1956. (J. D. A., Postgraduate Medical School of London, London, England)

A case is reported in which acute leukemia developed eighteen months after treatment with radioactive iodine for thyrotoxicosis. The patient, a sixty-seven year-old women, was first seen in May 1953; from July to August of that year, Carbimazole and thyroid extract were administered daily. Following the institution of radioiodine treatment in September, the patient improved and became euthyroid. Early in 1955, severe progressive anemia developed, but no marrow biopsy was done. Transfusion of whole blood over a three-week period was without significant benefit. Peripheral blood counts on April 20 and May 7, showing a low white-cell count and large numbers of blast cells, suggested the correct diagnosis. On May 1, a left-sided hemiplegia, melena, and ecchymoses on the left cheek and buttocks developed. Death occurred on May 9. Necropsy showed cerebral hemorrhage and acute myeloid leukemia.

The authors regard as unwarranted any conclusions about the part played by irradiation in inducing leukemia in this case. They consider it important, however, to assess the risks of radioiodine treatment as soon as possible by means of a large-scale survey comparing patients treated with radioiodine with a suitable control group.

Two tables.

Treatment of Peritoneal and Pleural Mesothelioma and Metastatic Malignancy with Radioactive Colloidal Gold. F. M. Lyle and Philip S. King. West. J. Surg. **64:** 336–342, June 1956. (F. M. L., W. 407 Riverside Ave., Spokane 1, Wash.)

The authors present the case of a 36-year old woman who was found to have a primary peritoneal mesothelioma with ascites persistently recurrent even after a thorough course of roentgen irradiation to the abdomen. After removal of 3,800 c.c. of fluid and the instillation of 100 mc of radioactive colloidal gold into the abdominal cavity, the ascites was considerably reduced, only two abdominal paracenteses being required in the ensuing nine months. The patient was living, in good health, three and one-half years after the use of the radioactive gold.

The physical characteristics of radioactive colloidal gold and its method of application and action are reviewed. The authors suggest its use (1) in preventing or slowing the growth of peritoneal implants when there has been a spill at operation for a malignant ovarian cyst; (2) in carcinoma of the stomach when the tumor has grown through the stomach wall or frozen sections reveal extensive involvement of the wall; (3) in carcinoma of the gastrointestinal tract with obstruction and ascites; (4) in carcinoma extending through the serosal wall of the bowel. The usual dosage is 50 to 100 mc in the pleural cavity and 100 to 200 mc in the peritoneal cavity, as a single dose.

Four photomicrographs; 1 photograph; 1 table.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

Radioactive Gold in the Treatment of Ovarian Carcinoma. H. B. Elkins and William C. Keettel. Am. J. Roentgenol. **75:** 1117–1123, June 1956. (H. B. E., State University of Iowa, Iowa City, Iowa)

This paper considers the discouraging salvage rate of ovarian carcinoma even when there is no reason to sus-

pect extension beyond the ovary at the time of surgery, and suggests a plan of treatment to meet this situation.

Since it seemed probable that even in early cases there might be malignant cells floating free in the abdominal cavity, cytologic studies of the peritoneal washings were made a routine in all gynecological patients undergoing abdominal surgery. Among 20 patients with proved ovarian cancer, positive or suspicious cells were found in 13. In 10 cases of Groups I and IIA (see below) there was no clinical evidence of break in the ovarian capsule and no evidence of neoplasm outside the ovary; yet, in 5 of these, positive cells were found in the peritoneal washings, paralleling the five-year mortality rate of patients with this clinical classification, namely, 48 per cent.

The authors recommend the following outline of treatment on the basis of Heyman's classification.

Group I. Removal of the primary tumor and all visible metastases possible: A total abdominal hysterectomy and bilateral salpingo-oophorectomy is performed. Radioactive gold is instilled at surgery or as soon thereafter as is possible. No external roentgen therapy is given.

Group II A. Ascites with malignant cells or spill of malignant cells at the time of operation. Treatment is the same as in Group I.

Group II B. Partial to total removal of the primary tumor but with visible metastases remaining. As much of the tumor is removed as possible, external irradiation is directed toward the area of known residual tumor, and radioactive gold is subsequently injected into the peritoneal cavity. The latter measure, the authors explain, is based on their experience of finding the pelvis "free of malignancy" following external irradiation while the upper abdomen was studded with recurrences. This presumably is the result of malignant cells floating in the peritoneal fluid and the radioactive gold is used for the specific purpose of eradicating these cells.

Groups III and IV. Recurrent and inoperable tumors. These are treated as individually indicated, for palliation, by any of the methods mentioned above.

Two photomicrographs; 7 tables.

JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

The Treatment of Inoperable Prostatic Carcinoma with Radioactive Gold. Miles W. Thomley, Louis M. Orr, and James L. Campbell. South. M. J. **49:** 146–148, February 1956. (1300 Kuhl Ave., Orlando, Fla.)

The authors have treated 62 patients with carcinoma of the prostate with Au^{198}, using the retropubic approach for injection. All patients were selected from a group which could not be cured by radical prostatectomy and yet showed no evidence of distant metastasis. There were 8 deaths in this series; many patients are said to be living with palpable evidence of their disease, and others "to all intents and purposes appear to be cured." No further statistics are given, but the authors consider the results in general to be encouraging.

Recording of Radioactivity in the Blood, Liver, and Prostate Following Interstitial Administration of Au^{198} in Carcinoma of the Prostate. Wayne M. Rounds and Titus C. Evans. Am. J. Roentgenol. **75:** 1132–1138, June 1956. (W. M. R., 1300 University Ave., Madison 6, Wisc.)

A study has been made of the degree of radioactivity in the blood stream and liver at various times following interstitial injection of radiogold into the prostate for carcinoma. Questions are raised as to how much of the radioactive material remains at the injection site and the rate and degree to which the gold leaves the operative region.

In the method described by the authors for determining blood levels of radioactivity, counting of blood samples is begun immediately on prostatic injection and from these counts the amount of Au^{198} in the circulating blood volume is calculated. It was found that activity in the blood rises to rather high but variable levels soon after prostatic injection, usually in a matter of a few minutes. This is believed to be referable to the injection of vascular channels either directly or *via* a rent in highly vascular tissue by the injecting needle. Radioactivity in the blood falls rapidly following its initial rise, with a half-time as long as eight minutes.

Studies of activity in the liver indicate that the first gold reaches that organ in less than one minute, in a manner similar to that following direct intravenous administration. The main collection of radioactive material occurs during and immediately after the operative procedure. A calculation of the amount of activity reaching the liver indicates that the radiation dose is occasionally in a range that has produced liver damage in experimental animals.

Any factor which will aid mechanical entry of gold into vascular channels at the injection site in the prostate will account for the initial high amount of circulating radioactive material. The authors were not able to show that the use of adrenalin or hyaluronidase had any effect on the amount of circulating gold. Radioactivity in the blood is so much higher in interstitial injection procedures than it is following intracavitary administration that the two technics are not comparable from the point of view of possible blood-borne toxicity to distant organs.

Eight graphs; 1 table. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Acute Radiation Death of Dogs Receiving a Single Massive Dose of Intravenous Radioactive Gold. P. F. Hahn, Andrew H. Jackson, Frank E. Staggers, Marvin A. Jackson, and E. L. Carothers. Am. J. Roentgenol. **75:** 1139–1143, June 1956. (P. F. H., Meharry Medical College, Nashville 8, Tenn.)

Nine young dogs given a single massive dose of radioactive colloidal gold (4.4 to 66.7 mc/kg.) all died within fifteen days, the majority in less than eleven days, of an acute radiation disorder characterized by changes in the blood, depression of bone marrow, and hemorrhagic phenomena. The histologic changes were similar to those following external irradiation but were variable in intensity due to the beta emission and the highly selective uptake of the particulate gold colloid by the reticuloendothelial system. A high degree of liver resistance was noted. The spleen showed lymphoid destruction, with congestion and ultimate shrinkage. The lymph nodes were hypoplastic.

It appears likely that the marked hypoplasia or aplasia of the bone marrow was a major cause of death, allowing any intercurrent infection, especially in the lung, to proceed unchecked. Intestinal hemorrhage was probably another immediate cause of death. The slight damage to the kidneys, adrenals, and heart was presumably due to the paucity of reticuloendothelial

tissue in those organs. Anemia was prompt and pronounced.

The younger animals appeared to be more susceptible to the radiation effects.

Two tables. JACK E. CARLISLE, M.D.
Shreveport, La.

Diagnostic Significance of Radioactive Isotopes in Early Cancer of the Alimentary Tract, Especially the Esophagus and the Cardia. Komei Nakayama. Surgery **39**: 736–759, May 1956. (School of Medicine, Chiba University, Chiba, Japan)

The author proposes a diagnostic method for tumors in the alimentary tract, especially those in early stages, involving the use of radioactive phosphorus. The procedure is based entirely upon a biochemical feature of malignant tissue, namely, its markedly selective uptake of P^{32}, attributable to the enhanced metabolism of the cancer cell.

Radioactive phosphorus, suitably diluted, was administered intramuscularly for a total dose of 300 to 500 microcuries of the isotope. Six to eight hours following injection, counts were obtained with the Geiger-Müller counter. In the esophagus, the counter (5 mm. in diameter and 20 mm. long) was introduced through the esophagoscope. For the stomach a somewhat smaller counter was used.

The method was employed in a total of 75 patients with lesions of the esophagus and cardia, of which 58 were malignant and 17 benign. In all malignant cases high counts were obtained; in the 17 benign lesions, the count was within normal limits. In 90 persons with disease in areas of the gastrointestinal tract other than the esophagus and the cardia, a normal count was obtained in both these areas. The reliability for stomach lesions was 97 per cent in 61 malignant tumors, and 100 per cent in 29 benign cases.

The method proved also to be applicable to the lymph nodes, furnishing indication for the type of operation to be used in the radical treatment of cancer. Certain carcinomas of the alimentary tract do not yield a high count, as mucinous carcinoma, in which degenerative changes are often pronounced and the metabolism of phosphorus is markedly reduced, and scirrhous carcinoma.

This diagnostic method is considered to supply specific information not obtainable by other forms of examination. Its intelligent application together with conventional procedures, such as roentgenography, endoscopic study, and smear tests, facilitates a much more accurate diagnosis of cancer of the alimentary tract.

Twenty-five illustrations, including 3 roentgenograms and 11 autoradiographs; 3 tables.

A Transilluminator for Use with the Curved Geiger Counter. An Aid to Localization of Posterior Intraocular Tumors. Charles I. Thomas and Jack S. Krohmer. Arch. Ophth. **55**: 413–414, March 1956. (Western Reserve University School of Medicine, Cleveland, Ohio)

As studies on the uptake of radioactive phosphorus by intraocular tumors have progressed, numerous technical modifications have been introduced to facilitate measurements in posteriorly situated neoplasms. The authors briefly describe one such instrument, a transilluminator which is attached directly to the counter probe. This is designed to give some visual aid in more precise determination of the scleral area over which the counter should be placed. It is small enough to be inserted through the conjunctival incision and is attached to the counter probe with its illuminating end immediately adjacent to the mica window.

One photograph.

Small End-Window and Angle-Window Geiger Counters. Measurement of Radioactivity in Intraocular Tumors Following Injection of Radioactive Phosphorus. Charles I. Thomas, Jack S. Krohmer, William J. MacIntyre, and Mary Bovington. Arch. Ophth. **55**: 519–521, April 1956. (Western Reserve University School of Medicine, Cleveland, Ohio)

In previous studies of the uptake of radioactive phosphorus by ocular neoplasms in experimental animals, the authors used the same counter probes that had been designed for clinical determinations. Both the end-window and angle-type counters, however, proved to be a little too large for satisfactory readings over the eyes of small animals. In the present paper, smaller end-window and angle-window counter probes are described, which have greatly facilitated determination of P^{32} uptake; in fact, the smaller counter has proved so adequate that it is being employed in clinical measurements on patients with ocular lesions anterior to the equator.

One photograph; 1 diagram; 1 table.

Radioyttrium (Y^{90}) for the Palliative Treatment of Effusions Due to Malignancy. Elsie P. Siegel, Hiram E. Hart, Milton Brothers, Herta Spencer, and Daniel Laszlo. J.A.M.A. **161**: 499–503, June 9, 1956. (D. L., 210th St. and Bainbridge Ave., New York, N.Y.)

Radioyttrium (Y^{90}) is a pure beta emitter with a maximum energy of 2.2 MEV, a maximum tissue range of 1.1 cm., and a half-life of sixty-one hours. The effectiveness of intracavitary injection of this substance in alleviating pleural and peritoneal effusions was studied in 16 patients with cancer. Thirteen received Y^{90} intrapleurally and 3 intraperitoneally for treatment of proved malignant effusions. Seven of the 13 patients with intrapleural disease appeared to have derived benefit. Six of these required no further thoracentesis during a follow-up interval at least as long as the pretreatment period. Of the 3 patients with intraperitoneal effusions, 2 died too soon for evaluation of the results of treatment. The third, who had carcinoma of the breast with peritoneal carcinomatosis, responded well.

To summarize the therapeutic results in the 16 patients included in this series: in 8 patients there was good control of fluid; in 3 there was slight or questionable decrease; in 2 there was no improvement; in 1 results were indeterminate; and in 2 death occurred too early for evaluation.

There were no clinical side-reactions to the use of Y^{90}. The cases coming to autopsy revealed various degrees of thickening of the pleura. No radiation damage to lungs, adjacent organs, or to the bone marrow was noted.

The method of administration of Y^{90} is described in detail. After intracavitary injection, only small amounts of the isotope were found in the blood, urine, and stool, and in the tissue samples assayed. Localization is probably due to formation of colloids of yttrium with the constituents of the fluid. Should the isotope accidentally enter the circulation, a method for rapid re-

moval is available by the use of the calcium chelate of edathamil. The amount of Y^{90} administered ranged from 10 to 40 mc.

Two diagrams; 2 tables.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

Dosage Calculations for Rotation Therapy, with Special Reference to Cobalt 60. H. E. Johns, M. T. Morrison, and G. F. Whitmore. Am. J. Roentgenol. **75:** 1105–1116, June 1956. (University of Saskatchewan, Saskatoon, Saskatchewan, Canada)

In rotation therapy both the focal skin distance and the field size on the skin vary continuously, so that calculations of skin and tumor doses from conventional depth dose tables are difficult. By utilization of the concept of tumor-air ratios the dose at the tumor can be reasonably calculated, provided the source-to-tumor distance and the field size at the tumor level are both known. In this paper the authors develop fairly complete tables for tumor-air ratios for 200-kv radiations and also for cobalt 60. Examples are given for calculation of tumor-air ratios in typical lesions involving the lung or urinary bladder.

Briefly, tumor-air ratios are calculated by measurement of the depth of the tumor below the skin surface at regular intervals (*e.g.*, 20-degree intervals) around the surface being irradiated. Skin-to-depth dose ratio is then determined for each field, from conventional depth dose tables for radiations of appropriate quality. If desired, the average values for any given step-up can be computed by summation of the individual field doses divided by the number of fields calculated.

The author also demonstrates computations for determination of dose at any point in the rotation distribution, specifically at points not in the axis of the beam or the mid point of the tumor.

This is a highly technical paper which does not lend itself well to abstracting. Included are extensive tables demonstrating tumor-air ratios for circular and rectangular fields over a wide area range, for half-value layers of from 1 to 4 mm. copper, and for cobalt-60 radiation.

Four diagrams; 4 graphs; 7 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Studies of the Localization of Radioactive Gallium (Ga^{72}) in Bone Lesions. H. C. Dudley, H. A. Markowitz, and T. G. Mitchell. J. Bone & Joint Surg. **38-A:** 627–637, June 1956. (U. S. Naval Hospital, St. Albans, N. Y.)

Previous studies with radioactive gallium have shown that the metal is deposited in bone and that it has a particular affinity for areas of osteoblastic activity. It was hoped that Ga^{72} scanning might be useful in the localization of various lesions involving bone before changes had occurred which were evident on roentgenographic examination. This has been possible in several patients, but there have also been a number of failures, including false positives and the missing of small but clearly positive areas.

Sixty-six cases of proved malignant lesions were studied by scanning procedures after the administration of radioactive gallium. In 9 cases which were negative by scanning methods, there were no clinical or roentgenographic evidences of bone involvement. In 28 cases the findings by scanning were questionable, and only a fair correlation existed with the known clinical findings. It was in this group with small bone lesions that the Ga^{72} scanning proved unreliable. In 29 cases which were strongly positive by Ga^{72} scanning, the correlation with clinical findings was excellent.

A group of non-malignant bone lesions was also studied. In 3 cases of osseous tuberculosis no definite conclusions were reached. In several cases of chronic osteomyelitis there was no significant increase in radioactive gallium concentration, but in a number of cases of healing osteomyelitic lesions there was an increase in radioactivity, indicating increased osteoblastic activity.

Twenty-nine healing fractures were studied by this technic and the degree of Ga^{72} localization was correlated with the time following injury and the healing process. In early fractures, there was no significant concentration of Ga^{72}. As healing progressed the concentration increased.

On the basis of these results, it appears that Ga^{72} scanning technics may be useful as a means of predicting the rate of healing or as a means of studying basic metabolism in healing bone lesions.

One figure; 5 tables.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Radioactive Iron Studies in Routine Haematological Practice. G. Wetherley-Mein, M. R. S. Hutt, W. A. Langmead, and M. J. Hill. Brit. M. J. **1:** 1445–1449, June 23, 1956. (Louis Jenner Laboratory and Department of Physics, St. Thomas's Hospital and Medical School, London, England)

The authors discuss the value of intravenous radioactive iron studies in routine hematological practice in an attempt to determine whether in individual cases these investigations contribute anything to the diagnosis and treatment which cannot be obtained by simpler technics. The findings are based on a series of 70 patients with hematologic disorders, to whom tracer doses of the isotope were administered. The behavior of the Fe^{59} was followed by estimating plasma clearance and the percentage of the injected dose appearing in red cells over a ten- to fourteen-day period. Measurements of distribution within the body were made by external surface-counting technics.

On the basis of the studies, the patients could be divided into two groups: In the first and larger group the mechanism of anemia had been clearly established by routine technics, and the iron studies had chiefly a corroborative function; in the second group a presumptive diagnosis, established by routine methods, was confirmed by the isotope study and a fairly clear dynamic picture of erythropoietic activity was obtained, thus providing a rational basis for treatment. The iron studies were found to be of particular value in this latter group; 5 illustrative cases are presented.

It is concluded that, while the investigation may be conducted with little difficulty, it is not an indispensable aid in the diagnosis and treatment of the majority of blood disorders. It is, however, clear that in a number of patients iron tracer studies demonstrate objectively an erythropoietic abnormality which can only be inferred from even the most comprehensive routine investigations. Furthermore, estimation of red-cell survival and radioactive iron studies are at present the only readily available laboratory technics by which the dynamics of erythropoiesis can be studied. It is felt

that these technics have a definite place in the routine investigation of hematologic disorders, contributing not only to an increased understanding of normal and abnormal erythropoiesis but also to the provision of a logical basis for therapy.

Eight graphs.

An Autoradiographic Study of Organically Bound Carbon-14 in Growing Epiphyseal Cartilage and Bone. Richard C. Greulich. J. Bone & Joint Surg. **38-A:** 611–626, June 1956.

The author presents data obtained from a series of autoradiographic preparations which demonstrate the formation of the components of the organic bone matrix of the young rat during rapid growth. The formation of labeled epiphyseal-cartilage matrix is also described. The method of study consisted of observing the distribution of a single, subcutaneous tracer dose of sodium bicarbonate labeled with C^{14} in bone and epiphyseal cartilage by the technic of coated autoradiography.

It was found that the radioactive carbon was deposited primarily in the organic components of bone and epiphyseal cartilage rather than in the mineral portions. The newly synthesized protein, particularly collagen, contained the greatest amount of the labeled organic material in the matrix of both bone and cartilage. Chondroitin sulfate in cartilage may also contain some of the labeled organic material.

Study of autoradiographs of epiphyseal cartilage over a period of three days after the injection of the labeled sodium bicarbonate indicated the formation of labeled matrix by the chondrocytes. These latter elements appeared to synthesize and extrude the labeled matrix at different rates in various portions of the cartilage. After formation, the matrix passes from the cell into the surrounding stroma.

Study of the autoradiographic reactions four hours after administration in the long bone showed that the greatest intensity was present in the organic matrix of the subepipyhyseal bone and in the periosteal region throughout the length of the diaphysis. In general, these autoradiographic reactions and the later reactions through seventy-two hours, of the bone matrix are similar in position to those previously described for mineral-seeking isotopes.

Twenty-two photomicrographs.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

RADIATION EFFECTS

Hazards of Radiation. Medical Research Council's Report. Brit. M. J. **1:** 1418–1420, June 16, 1956.

This is a summary of the Medical Research Council's report on *The Hazards to Man of Nuclear and Allied Radiations* (published by Her Majesty's Stationery Office, London, June 1956). The main conclusion of the report is that "adequate justification should be required for the employment of any source of ionizing radiation on however small a scale." This follows a review of the effects of radiation from such sources as nuclear weapons, medical radiography, shoe-fitting apparatus, luminous watches, television sets, cosmic rays, isotopes, and industrial x-ray machines.

Cancer of the Thyroid and Irradiation. Erich M. Uhlmann. J.A.M.A. **161:** 504–507, June 9, 1956. (29th St. and Ellis Ave., Chicago, Ill.)

A survey of the literature and an analysis of his own experience is held by the author to afford no support for the view that there is an association between the increasing frequency of carcinoma of the thyroid in children and their previous exposure to irradiation for treatment of benign lesions in the head and neck area. Among the arguments used to support his contention is that, although irradiation of the tonsils and adenoid tissues was especially popular between the years 1920 and 1925, the number of reported cases of thyroid carcinoma developing within the next five to ten years was not excessive. Another point is that in adults the distribution of carcinoma of the thyroid between the two sexes is 7 to 1 in preference of females. In children there is still a preferential affliction of girls, but the ratio is less drastic. If irradiation of benign conditions were a cause, the distribution should be relatively equal, since irradiation for benign conditions in childhood has not been associated with any sex preference. A further point to be taken into consideration is that x-ray therapy for assumed benign conditions in the neck may have been given at a time when unrecognized carcinoma of the thyroid existed.

The author's measurements on his own patients being treated for hypertrophic lymphoid tissue in the pharynx and tonsils showed that with the customary technic, the total radiation reaching the skin above the thyroid is 18 r, delivered over a period of two weeks. Actually, the amount of radiation observed in the thyroid area during fluoroscopic examination of the chest is much greater than that applied to the same area during the treatment of benign conditions.

The author also reports his observations on 25 patients with carcinoma of the thyroid up to and including those twenty years old, seen in a period of eighteen years. Four of these had had previous irradiation. The time intervals between irradiation and establishment of the diagnosis of cancer in these cases were eight years, nine years, fourteen years, and fifteen years, respectively. In 2 instances siblings of unirradiated patients with cancer had received irradiation and remained well. During the same eighteen year interval, approximately 2,500 children received radiation therapy for hypertrophic lymphoid tissue in the pharynx and enlarged tonsils.

In reviewing the relationship of radiation to later development of carcinoma of the skin not a single instance was found where less than 1,500 r had been applied to the area of cancer development. In the majority of these patients, the amount of radiation was more than 500 r.

The author concludes that statistically the correlation of irradiation and development of carcinoma of the thyroid is untenable. JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

The Danger of Cancer from Thorotrast as a Diagnostic Medium. Earl Budin and J. Gershon-Cohen. Am. J. Roentgenol. **75:** 1188–1193, June 1956. (J. G.-C., 255 S. 17th St., Philadelphia 3, Penna.)

The properties of Thorotrast are reviewed and 2 cases of cancer developing after its use a contrast agent

are cited: a cancer of the breast appearing eighteen years after injection of the medium into the ductal system and a carcinoma of the splenic flexure of the colon sixteen years after the introduction of Thorotrast into the spleen. In the latter case there is a margin for speculation as to the relationship of the diagnostic procedure and the subsequent development of cancer, but the authors believe that the possibility exists. In any event, they make a strong plea that the use of Thorotrast as a contrast agent be drastically restricted.

The fact that there are relatively few reports of cancer incident to the use of this medium is explained by the long latent period between injection and the appearance of malignant changes, during which death may have occurred from other causes. [Both of the cases mentioned here are scheduled for publication elsewhere.]

Four roentgenograms. JACK E. CARLISLE, M.D.
Shreveport, La.

The Dose to the Trachea and Bronchi from the Decay Products of Radon and Thoron. A. C. Chamberlain and E. D. Dyson. Brit. J. Radiol. **29:** 317–325, June 1956. (Atomic Energy Research Establishment, Harwell, England)

Utilizing a relatively simple apparatus the authors determined the amount of decay product activity from radon and thorium which was deposited on the walls of a straight tube approximating the size and length of a human windpipe. Similar experiments were done with latex models of a human larynx, trachea, and major bronchi.

It has previously been shown by others that most of the dosage to the trachea and bronchi, when radon is inhaled, is from the radon decay products. Inhalation of radon with its decay products was found to result in a lung gamma activity 120 times that produced by inhaling the same radon concentration without the decay products. The authors confirmed these findings and also demonstrated that the presence of a sticky solution on the windpipe or a straight tube made no significant difference in the amount of deposit.

A high deposit in the larynx and upper trachea was noted, and the highest deposit in the straight tube was within an inch or so of the inlet. It was thought that this high deposit was mostly due to the effect of entrance conditions. The deposit was likewise high at the carina (two to three times that on nearby surfaces).

If the decay products were allowed to attach to condensation nuclei, then the deposit on the wall of the straight tube and the model larynx and trachea was only 0.2 per cent of that in filtered air. This finding holds true for the trachea and main bronchi only, and may be the reverse in the alveoli of the lungs.

The use of the tube apparatus gives a practical method of measuring the amounts of uncombined decay products in the atmosphere. A table is included which can be utilized for this purpose. If the number of uncombined decay product atoms per cubic centimeter of air is known, then at a given breathing rate the number deposited per square centimeter of the trachea or bronchi can be determined.

Thorium and radon deliver an entirely different dosage, due to the much longer half-life of thorium, which is probably removed from the trachea before complete decay has taken place.

With the permissible level for radon and its daughter products as recommended by the International Commission on Radiation Protection (10^{-10} c/l. for continuous exposure and 3×10^{-10} c/l. for a forty-hour week), the dosage to bronchi will approximate 0.25 rad/week. If an RBE of 10 is given the alpha emission from the radon, then this would equal 2.5 rem/week which exceeds the 0.3 rem/week basic permissible level.

Apparently the Joachimstal mines and some mines in America have radon levels of 3×10^{-9} c/l., which would deliver several rads per week to the bronchial epithelium without allowance for the RBE of the alpha rays.

One photograph; 5 figures; 5 tables.

JAMES W. BUICE, M.D.
University of Arkansas

Genetic Speculation Based upon Animal Experimentation in Relation to Actual Human Experiences, in the Treatment of Female Infertility and Sterility by X-Ray Therapy. Ira I. Kaplan. J. Obst. & Gynaec. Brit. Emp. **63:** 397–399, June 1956. (Radiation Therapy Department, Bellevue Hospital, New York 16, N. Y.)

The author re-emphasizes his opinion that the results of radiation therapy for infertility and sterility in human females are harmless to the treated women, their children, and their children's children. He again questions the validity of genetic speculation based upon animal experimentation, and points out that no one has been able to demonstrate the occurrence of genetic abnormalities, comparable to those noted in experimental animals, in women irradiated with the small dose of x-rays used in the treatmentf or infertility. See Abstracts in Radiology **57:** 298, 792, 1951; **63:** 626, 1954; **64:** 159, 1955.

THEODORE E. KEATS, M.D.
University of Missouri

An Analysis of the Effects of Total-Body X-Irradiation on the Body Weight of White Swiss Mice. II. Body-Weight Changes of Male Mice as a Biological Dosimeter. William H. Chapman and Edward A. Jerome. Radiation Res. **4:** 519–531, June 1956. (Radioisotope Laboratory, U. S. Naval Hospital, St. Albans, N. Y.)

In order to explore the possibilities of basing a dosimetric technic on the weight response of male albino mice to radiation, the relation between weight changes and amount of radiation was analyzed for each of the first thirteen days after irradiation. A linear relation was found between the per cent weight change and the amount of radiation over the lethal range on each of the postirradiation days, different constants being characteristic of different days. It was therefore possible to develop a formula for estimating dose from information concerning the day on which a given average per cent weight change occurred. The relative error in estimating dosage in this manner was in the order of 3 per cent, though different for the various doses on the several days.

Additional data and analyses are given for doses within the sublethal and supralethal ranges, though it appears that data within these ranges cannot be subsumed under the formulae effective within the lethal range.

Three figures; 6 tables. Authors' Abstract

The Effect of Transfusions of Blood Showing Extreme Leukocytosis on Survival of X-Irradiated Mice. C. C. Congdon, T. W. McKinley, Jr., H. Sutton, and P. Urso, Jr. Radiation Res. **4:** 424–434, May 1956. (National Cancer Institute, Bethesda, Md.)

The authors have carried out experiments which they believe indicate the effectiveness of leukemoid blood from tumor-bearing mice in promoting recovery of total-body irradiated mice (750 r) as measured by regeneration of hematopoietic tissue and by survival. The activity of the blood was associated with the formed elements. The extreme granulocytosis which occurred suggests that the granulocyte may be capable of causing recovery from irradiation injury.

The hypothesis that the granulocyte alone is responsible for recovery when leukemoid blood is administered depends on the determination that other formed elements in the injected leukemoid blood do not play a critical role in producing survival. From evidence at hand, there is no reason to believe that the transfused red blood cells, lymphocytes, or platelets are primarily responsible for the recovery, although there is also no reason that those included in the transfusions should not carry out their normal functions in the irradiated host. No information is available on monocytes or eosinophils in relation to the mechanism of recovery. The plasma from leukemoid blood did not influence the recovery of irradiated mice under the conditions of the experiments. The view that the granulocyte is an important cell in producing recovery fits in well with other data in the literature correlating the presence of this cell type with presence or absence of bacterial infection and with survival of irradiated mice.

The mechanism of action of the granulocyte is not likely to be transplantation-repopulation, since it does not divide or, so far as is known, dedifferentiate into a more primitive blast cell. The cell would help control bacterial infection, but the rapid regeneration of the peripheral white blood cell elements is probably not explained by this action alone. It is feasible to postulate a humoral action for the granulocyte, but this has not been demonstrated by the authors' experiments.

Modification of Acute Intestinal Radiation Syndrome Through Shielding. Marguerite N. Swift and S. Tom Taketa. Am. J. Physiol. **185:** 85–91, April 1956. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

Mortality associated with intestinal injury in rats occurring three to five days after 1,000-r x-irradiation was found by the authors to be significantly decreased by the shielding, during exposure, of a small exteriorized section of duodenum or ileum. No protection was obtained, however, by shielding either the distal half of the cecum or the whole stomach.

On the fourth day after irradiation with 1,000 r, considerable recovery of the radiation-induced total small intestine weight loss was observed in rats exposed with the ileum shielded, whereas no recovery was evident in non-shielded controls at this time. This effect was not demonstrable at 875 r, a dose that produced no acute intestinal deaths in either control or experimental group. Mortality at four days was significantly reduced among rats receiving an intermediate dose of 500 r to the ileal section as compared to those receiving 1,000 r under the same exposure conditions. The ileal section itself showed essentially no decrease in weight after 500 r.

Prevention of Intestinal Radiation Death by Removal of the Irradiated Intestine. James W. Osborne. Radiation Res. **4:** 541–546, June 1956. (Radiation Research Laboratory, State University of Iowa, Iowa City, Iowa)

An investigation was undertaken to check the role of the intestine at later stages of what has been called acute intestinal radiation death. Male rats weighing 250 to 275 gm. were subjected to x-irradiation in the range 2,200 to 4,000 r, delivered in a single exposure to the whole body, abdomen, or portion of the exteriorized intestine. In the last group, surgical resection of the irradiated portion was performed in some cases. Survival times and intestinal pathology were studied.

Whole-body- and abdomen-irradiated animals lived an average of 3.2 and 3.5 days, respectively. The histologic changes were qualitatively the same in all groups of animals checked, although denudation of the intestinal epithelium was slower in intestine-irradiated animals. Animals in which only 20 per cent of the intestine was irradiated lived about twelve days. Exposure of 50 per cent, 80 per cent, or 100 per cent of the exteriorized intestine produced death in about 5.5 days, with no animal living longer than 7.4 days. Thus, some factor in the abdomen exclusive of the jejunum and ileum (possibly in the duodenum) is responsible for either decreased rate of denudation, increased survival time, or both. This does not imply that these two are causally related, although they may be.

Surgical removal of the x-rayed portion in intestine-irradiated animals provided indefinite survival in one-third of the group (6 lived indefinitely, 3 died from complications after having outlived the controls). Since it was possible to save animals by removing the irradiated portion as late as ninety-six hours after exposure, the conclusions are: (1) that intestinal damage of some sort is a primary factor in causing death and (2) that the irradiated intestine must remain in the animal for almost the entire life expectancy in order to cause death. Author's Abstract

The Relative Biological Effectiveness of Fast Neutrons in Mice. R. E. Carter, V. P. Bond, and P. H. Seymour. Radiation Res. **4:** 413–423, May 1956. (R. E. C., Department of Pediatrics, University of Chicago Medical School, Chicago, Ill.)

On the basis of data obtained with CF1 mice exposed to either fast neutrons or 250-kvp x-rays, and with mortality and spleen, thymus, and gut weight loss as biological end-points, the authors make the following statements:

"1. The relative biological effectiveness of fast neutrons as generated for this experiment and 250 kvp x-rays were: 30-day mortality 1.6; spleen weight loss 1.7; thymus weight loss 1.5; gut weight loss 2.3.

"2. The values obtained in the present experiment, with neutrons ranging in energy from approximately 3 to about 20 MEV, compare closely with those obtained by other investigators using the same biological end point but a monochromatic 14-MEV neutron beam. Thus it would appear that there is probably no marked variation in the relative biological effectiveness of neutrons over this energy range, for the test systems employed.

"3. The shortened survival time for neutron-irradiated mice compared with that of x-irradiated mice is again confirmed."

Five figures; 4 tables.

Effect of Total Body X-irradiation on Plasma Volume, Red Cell Volume, Blood Volume and Thiocyanate Space in Normal and Splenectomized Rats. Kee-Chang Huang and James H. Bondurant. Am. J. Physiol. **185:** 446–449, June 1956. (Department of Pharmacology, University of Louisville School of Medicine, Louisville, Ky.)

A single dose of 600 r of x-irradiation was given to groups of non-anesthetized normal and splenectomized rats. Simultaneous estimations of plasma volume, red cell volume, and thiocyanate space were performed in these animals before and after irradiation. In normal rats the plasma volume decreased in the first eight days postirradiation but showed a significant increase by the tenth day. The reduction of red cell volume and hematocrit developed gradually and reached a marked degree by the tenth day. The blood volume after irradiation was generally larger than normal.

The thiocyanate space showed an increase on the fourth day after irradiation, a decrease in the next period and elevation again by the tenth day postirradiation. In splenectomized rats the change of thiocyanate space was similar to that observed in normal animals; changes of blood volume were varied. A marked reduction of red cell volume with an increase, probably compensatory, of plasma volume, developed by the fourth day after irradiation.

One table.

X-Irradiation and Liver Regeneration in Partially Hepatectomized Rats. Leon L. Gershbein. Am. J. Physiol. **185:** 245–249, May 1956. (Department of Biology, Illinois Institute of Technology, Chicago, Ill.)

The present study was undertaken to determine the effect on the rat liver of unfiltered x-rays ranging in dosages up to 20,000 r, use being made of a relatively sensitive criterion, namely, the extent of liver regeneration in partially hepatectomized rats. In the investigation only the liver remaining after surgery was irradiated. In this way the possibility that the changes might stem from damage to other tissues that could be reflected in the liver, rather than the effect of radiation on the liver itself, is minimized. No noteworthy effect was evident over an eleven-day period in any of the irradiated animals except for those exposed to 20,000 r. The extent of the liver regeneration in the irradiated animals did not differ statistically from that of the partially hepatectomized controls, evidently attesting to a definite radioresistance for rat liver under these conditions.

Because liver regeneration is a very rapid process, a relatively short period of time (eleven days) was employed in the determination of the respective increments. It would be of interest to follow liver alterations, especially those in rats exposed to a dosage of 20,000 r, over more protracted periods.

Three photomicrographs.

Enlargement of the Liver in Sprague-Dawley Rats Following Whole-Body X-Irradiation. Helen Supplee, E. O. Weinman, and C. Entenman. Am. J. Physiol. **185:** 583–588, June 1956. (Biochemistry Branch, U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

In earlier investigations it was observed that livers of irradiated rats were larger than those of fasted controls of the same body weights. In the experiments recorded here the authors sought to determine the time of onset of the response, its variations with whole-body doses ranging from 200 to 5,000 r, and the changes in the fat, protein, carbohydrate, and water contents of the liver.

A significant increase in liver mass was found in rats as early as six hours after exposure to as small a dose as 200 r of 250-kvp x-rays. Water, lipids, and glycogen contributed to this, but the most striking change was in the glycogen content. Following a total-body dose of 1,200 r, the increase in glycogen accounted for two-thirds of the total increase in solid constituents of the liver.

Five figures; 2 tables.

Biosynthesis of Fatty Acids in Liver and Intestine of Intact Normal, Fasted and X-Irradiated Rats. John G. Coniglio, Donald B. McCormick, and Granville W. Hudson. Am. J. Physiol. **185:** 577–582, June 1956. (Departments of Biochemistry and Radiology, Vanderbilt University School of Medicine, Nashville, Tenn.)

The authors have found that in the normal rat a seventy-two-hour fasting period has less effect on the intestinal incorporation of C^{14}-acetate into fatty acids than on hepatic incorporation. Glycogen concentration and hepatic incorporation of acetate into fatty acids increased in irradiated, fasted rats (750 r total-body x-irradiation) compared to fasted controls. Intestinal incorporation of C^{14}-acetate into fatty acids decreased in the irradiated rat. A direct relationship between the amount of liver glycogen present and the amount of incorporation of C^{14} into fatty acids was not observed.

Two graphs; 4 tables.

Early Vasoconstriction Induced in the Isolated Rabbit's Ear by X-Radiation. Phillips M. Brooks, Herbert B. Gerstner, and Sidney A. Smith. Radiation Res. **4:** 500–509, June 1956. (Department of Radiobiology, USAF School of Aviation Medicine, Randolph Field, Texas)

Previous studies have demonstrated that x-radiation in excess of 2 kr induced in the isolated perfused rabbit's ear vasoconstriction associated with, but not clearly related to, a marked protein release (Am. J. Physiol. **182:** 459, 1955. Abst. in Radiology **67:** 156, 1956). The method employed at that time allowed flow measurements at five-minute intervals only and made it necessary to interrupt perfusion during irradiation; therefore, onset and time course of the vascular reaction could not be established. In the present study, determination of these factors was accomplished with an improved technic that permitted ear perfusion and flow rate recording to be performed continuously. With this technic, measurements were performed on 112 isolated rabbit ears prior to, during, and after exposure to various doses of x-radiation administered at a rate of 1 kr/min.

Doses in excess of 5 kr were found to induce a marked vasoconstriction. This reaction became noticeable several minutes after irradiation was begun and progressed to complete arrest of perfusion flow at higher doses. Approximately twenty minutes after cessation of perfusion flow, the vascular bed opened again, and subnormal or normal flow rates were resumed even when irradiation was continued.

The irradiated ears showed a marked protein washout.

Four graphs; 1 table.

X-Irradiation and Lipoprotein Metabolism in Various Species. John E. Hewitt and Thomas L. Hayes. Am. J. Physiol. **185:** 257–264, May 1956. (Donner Laboratory, University of California, Berkeley, Calif.)

The changes in lipoprotein concentration following total-body x-irradiation of the rabbit, dog, rat, and mouse are described. The most striking lipoprotein changes in the four species were: (*a*) a large increase in the concentration of the low-density lipoproteins of the rabbit at thirty hours postirradiation; (*b*) increased concentrations of the two lower-density classes and decreased concentrations in the highest-density class in the dog at ten to thirteen days postirradiation; (*c*) elevated concentrations of the high-density lipoproteins at three days and the low-density lipoproteins at eight days in the rat; (*d*) a pronounced decrease in the concentrations of the high-density lipoproteins of the mouse at four days.

Hyperlipoproteinemia is associated with higher average flotation rates for the lipoprotein molecules, indicating qualitative as well as quantitative changes in the metabolism of lipids in the irradiated animal. A relatively large increase in the concentration of the low-density lipoproteins precedes death from irradiation in the rabbit, rat, and dog.

Four figures; 1 table.

A Correlation of Early Radiation Changes in Lymphatic Tissues with Antitoxin-Producing Ability. William L. Williams, Richard D. Stoner, and William M. Hale. Yale J. Biol. & Med. **28:** 615–621, June 1956. (W. L. W., Division of Pathology and Microbiology, University of Tennessee, Memphis, Tenn.)

The authors describe their experiments, on mice, correlating (1) the morphological changes in lymphatic tissues following gamma irradiation with the alteration in ability of the animal to produce antitoxin and (2) the morphology of aging thymus with its increasing ability to produce antitoxin in transplants. The authors believe they have demonstrated the ability of undifferentiated cells (pre-plasmacytes?) of the reticuloendothelial system to produce antibodies in the absence of mature lymphocytes or plasma cells. This is contrary to other theories of antibody production appearing in the literature. Some have suggested that lymphocytes form or transport antibodies and may even be responsible for maintenance of normal serum globulin; others regard the plasma cell as either the site of origin or means of transportation.

The authors cite the work of Coons et al. (J. Exper. Med. **91:** 15, 1950; **92:** 35, 1950; **93:** 173, 1951), indicating that the only cell type which invariably fixes antigen is the reticuloendothelial phagocyte. Their own concept of the cells which have been shown to produce antibody is that, while they are members of the reticuloendothelial system, most of them have phagocytic ability under the proper stimulus. They are believed to represent a multipotential cell which may differentiate into a "transitional" cell and thence into a lymphocyte, plasma cell, or phagocytic cell.

Eight photomicrographs; 2 charts.

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RaD, RaE, and Po in the Atmosphere. P. King, L. B. Lockhart, Jr., R. A. Baus, R. L. Patterson, Jr., H. Friedman, and I. H. Blifford, Jr. Nucleonics **14:** 78–84, June 1956. (Naval Research Laboratory, Washington, D. C.)

This paper supplements data already available on the short-lived RaB and ThB concentrations in the atmosphere by an account of the longer-lived RaD, RaE, and Po.

Two methods were used. One involved collections of large volumes of rain water (100–600 gal.) and concentration of the activity with aluminum hydroxide floc followed by chemical separation. The other made use of high capacity air filter units with filter paper as the collecting medium. The activity was removed from the filter paper by chemical methods similar to those used for the rain water.

Results showed that the RaD activity collected by rain varies greatly with locality. Island locations such as Samoa (2 dpm/gal.) being least and inland areas (Glenview, Ill., 21 dpm/gal.) being greatest. There was no correlation between the concentration of activity in the sample and the quantity of dirt, character of the rain, or time between rains. Results obtained with the filter-paper collections were similar to those with rain water.

Four tables.

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Attenuation of 86- and 176-MEV Synchrotron X-Rays in Concrete and Lead. William Miller and Robert J. Kennedy. Radiation Res. **4:** 360–366, May 1956. (R. J. K., Food and Drug Administration, Department of Health, Education and Welfare, Washington, D. C.)

For synchrotron operating energies of 38, 86, and 176 MEV, the x-ray attenuation curves in concrete indicate an effective absorption coefficient of 0.021 $cm.^2/gm.$, in agreement with earlier measurements at 38 MEV and 185 MEV. For operating energies of 86 and 176 MEV, the broad-beam curves in lead give an effective absorption coefficient of 0.046 $cm.^2/gm.$ This agrees closely with earlier data obtained at 330 and 185 MEV.

Four figures.